

MICROTM

THE 6502/6809 JOURNAL



PET Feature

Growing Knowledge Trees

6502 and 6809 Memory Moves

Apple Printer Utilities



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THE 6502/6809 JOURNAL

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HDE Disk BASIC

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The Chieftain series includes 5¼- and 8-inch Winchesters that range from 4- to 60-megabyte capacity, and higher as technology advances. All hard disk Chieftains include 64-k memory with two serial ports and DOS69D disk operating system.

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The Chieftain Computer Systems:

Here are the Chieftain 6809-based hard disk computers that are destined to change data processing . . .



CHIEFTAIN 95W4

4-megabyte, 5¼-inch Winchester with a 360-k floppy disk drive (pictured).



CHIEFTAIN 95XW4

4-megabyte, 5¼-inch Winchester with a 750-k octo-density floppy disk drive.



CHIEFTAIN 98W15

15-megabyte, 5¼-inch Winchester with a 1-megabyte 8-inch floppy disk drive.



CHIEFTAIN 9W15T20

15-megabyte, 5¼-inch Winchester with a 20-megabyte tape streamer.

● 2-MHZ OPERATION

All Chieftains operate at 2-MHz, regardless of disk storage type or operating system used. Compare this to other hard disk systems, no matter **how** much they cost!

● DMA DATA TRANSFER

DMA data transfer to-and-from tape and disk is provided for optimum speed. A special design technique eliminates the necessity of halting the processor to wait for data which normally transfers at a slower speed, determined by the rotational velocity of the disk.

● RUNS UNDER DOS OR OS-9

No matter which Chieftain you select . . . 5¼- or 8-inch floppy, or 5¼- or 8-inch

Winchester with tape or floppy back-up . . . they **all** run under DOS or OS-9 with **no need** to modify hardware or software.

● UNBOUNDED FLEXIBILITY

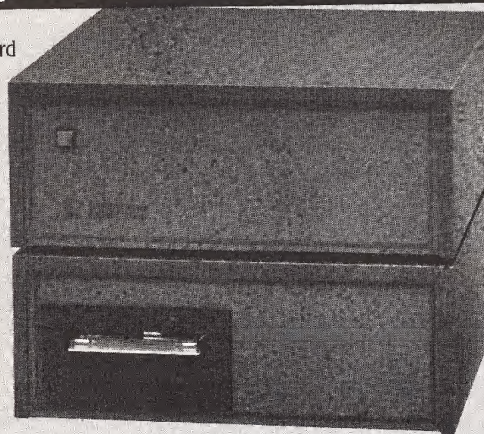
You'll probably never use it, but any Chieftain hard disk system can drive up to 20 other Winchesters, and four tape drives, with a single DMA interface board!

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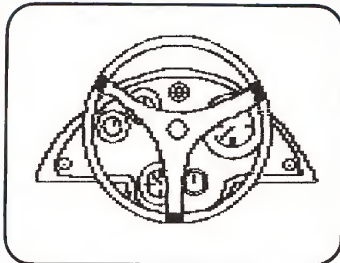
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About the Cover



This month's cover gets MICRO off to a flying start at the races. Increasing software and hardware sophistication make simulations possible that put you in the driver's seat. The MIT Artificial Intelligence lab has produced a microcomputer-videodisk combination that lets you simulate a drive through Aspen, Colorado, seeing on TV just what you would see through your windshield if you were actually there.

The cover graphic was generated on an Apple Graphics Tablet, and the output was produced on an IDS Color Printer by Susan Maras at Computerland of Nashua, New Hampshire.

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MICRO™

Editorial

Present Shock

Turning on Commodore's new SuperPET is a startling experience. The system's introductory menu modestly offers access to: BASIC; Pascal; FORTRAN; APL; Assembly; and Monitor. Merely hit the appropriate key!

The development of the microcomputer is proceeding at breathtaking speed. A ferociously efficient combination of high technology, intense international competition, and ready venture capital is generating new hardware faster than society can absorb the old. How rapidly the aerospace industry progressed, we once thought, marvelling at the short span between Kitty Hawk and the Moon. But microcomputers are advancing much more swiftly. Incredibly, the arrival of the new SuperPET coincides with ongoing use of the KIM-1, a 1977 single-board system still covered by MICRO. As a special effect, such an eerie foreshortening of time belongs in a *Star Trek* episode, like Commodore's imagemaster, William Shatner.

As we admire the development of ever-more-sophisticated microcomputer hardware, we should remember that each new system requires of its users an enormous investment of time. A case in point: IBM's new Personal Computer. Announced last year to universal acclaim, the system almost entirely lacks software that exploits its 16-bit potential. While the software industry strains to fill the huge gap that appeared the day the Personal Computer was introduced, even more advanced machines are being developed.

We must learn to recognize how conservative we are with our most precious investment, time. Otherwise, costly mistakes will be hard to avoid. For example, those who promoted novel keyboard designs in hopes of replacing the standard QWERTY arrangement have convinced almost no one, the marketplace least of all. We have invested far too much time in learning QWERTY to leave it even for a significantly better keyboard design. The zeal with which microcomputer owners go

on developing systems that are technological antiques should warn us that these systems, like QWERTY, will be with us for a long time to come. And as more and more new systems are introduced, sopping up more and more available time and energy, the gap between a new system's potential and the availability of resources to develop that potential seems likely to widen.

The solution to this problem is certainly not to stop building more advanced computers. The limits of the microelectronics revolution are not yet in sight, and we can look forward to ever more powerful microcomputers. What we must do is understand that the most important component in a working computer system — people — cannot fully process change at such a fast rate. Nor can we afford to discard huge investments of our time. Therefore, we must find ways to keep that investment on board. The SuperPET, for example, includes both the older 6502 and the newer 6809 processor, and can therefore run older as well as newer software. Radio Shack's recently announced Model 16 incorporates the even newer 68000 processor, yet also uses a Z-80. All older Model II software can still be used. In fact, it will even be possible to upgrade Model IIs with the 68000 board.

MICRO supports design decisions that make software compatible with different generations of a system. The same generation of people will be using many generations of computers. To stay in touch with us, the microcomputer revolution must be made compatible with the need imposed by human limits to use our time wisely.

This issue of MICRO spotlights Commodore's PET. Europe's most popular microcomputer, the PET is steadily attracting more American users. The program accompanying David Heise's feature article, "Growing Knowledge Trees," was written especially for the PET. However, the insight it offers MICRO readers into the concept of artificial intelligence makes it must reading for all.

Laurence Kepple

MICROTM

Letterbox

Dear Editor:

I would strongly recommend against your readers' taking, at face value, the comments made in your December 1981 Letterbox, "Atari Ad Attacked."

Mr. Kirby does not define "adapting." If Mr. Kirby takes an Atari program and makes a "similar" program, he may end up in the Austin court he mentions in his letter. The same rules apply to a computer program as to books, etc. It is not necessary to make a 100% duplicate in order to be found guilty of copyright infringement. For example, if he were to use an unusual approach or algorithm in only a part of his new "adapted" program (assuming that the Atari program itself makes it obvious that the contents are copyrighted), the remainder of the "adapted program" could be totally different, yet a copyright infringement could easily be regarded by the court as having occurred. Mr. Kirby will then be subject to a number of possible actions, ranging from criminal penalties, damages, court injunctions... or all of them.

A helpful publication, costing about \$12.00, is "The Copyright Kit," published by the National Attorney's Publications, Inc., P.O. Box 150, East Setauket, N.Y. This book explains copyrighting in layman's terms and clears up the muddy waters created by December's "intellectual property law" expert.

Stephen C. Carpenter
Mondriaanstraat 14
3262 TH Oud-Beijerland
The Netherlands

Dear Editor:

Your magazine is a very good one. My opinion might be illustrated by my collection of your issues. I started reading your magazine in late 1979. I currently have 38 issues, one reprint collection covering six more issues, and am requesting a recently missed issue. When I receive this issue, I will have access to information from 45 of the 46 issues you have placed on the market at this time.

I own an Apple II with 48K of memory, an Applesoft language card, and one DOS 3.3 disk drive. I find your coverage of the Apple to be not only very large in quantity but fine in quality. I also get a lot of ideas from the articles dealing with the other 6502/6809 machines.

Are there any plans to publish articles which describe the other CPU boards which run in the Apple? Even though you are a 6502/6809 journal, an article describing how a 6502 works with a Z80, 6800, 6809, 8088, and other chips would be very interesting.

Also, are any of your readers familiar with the new MTU 6502 machine? I recently received some literature describing it and it isn't too far from a "dream machine" itself. It appears to have hardware 18-bit addressing (yes, 18 not 16) and great bit map graphics. It also has a very sophisticated operating system.

I do have one final problem: A few months back, you had an article which described an operating system for the 6809. I believe it was OS/9 or something similar. But I don't remember seeing a manufacturer's name or address (or price for that matter). Did I simply overlook these or were they missing? Could you re-supply them? Does this operating system come in a format for the Apple II's various 6809 boards?

Larry W. Virden
1207 Rosehill Rd., Apt. 104
Reynoldsburg, OH 43068

Editor's note: The MICRO staff is very interested in hearing from readers who have experience using any of these CPU boards. Since these boards use the 6502 to handle the I/O and other functions, it would be valuable to see how the two CPU's cooperate with each other. Possible areas of coverage could include how the dual CPU's deal with cycle stealing, address translations, interrupts, parameter passing, etc.

The OS-9 operating system is available for the MILL 6809 card through Stellation Two, P.O. Box 2342, Santa Barbara, CA 93120; (805) 966-1140.

Dear Editor:

I just finished reading the March issue of MICRO. As an OSI user (I have a C2-4P MF system) I wish to thank you for your editorial "Hello, OSI?" and also for making the March issue an OSI Feature.

Let's hope that the cover photo is not a group of OSI users watching the OSI personal computer division going up in flames.

After reading the notation about the cover photo, I looked through my collection of computer manuals and found a copy of the manual prepared by Professors J.G. Kemeny and T.E. Kurtz dated June 1965. A statement of interest in the manual is: "The language that you will use is BASIC (Beginner's All-purpose Symbolic Instruction Code) which is at the same time precise, simple, and easy to understand."

J. Edward Loeffler, Jr.
Elkins Lake, Box 278
Huntsville, TX 77340

Dear Apple Owners:

In conjunction with the release of The Graphics Magician and the updated Complete Graphics System II, Penguin Software is announcing a new policy with our applications software for the Apple. The Complete Graphics System II, Special Effects, and The Graphics Magician will all now be available on non-protected disks.

We've been torn between two points of view. As computer users, we appreciate the ability to have several working copies of our applications software, and even the ability to go in and modify the code, if desired. We'd use programs such as VisiCalc or DB Master for dozens of other applications if we could have them running off several separate disks and didn't have to guard our master copies with such extreme care. Disks are fragile; we handle thousands of them, and no disk is absolutely 100% error-proof. Being programmers also, occasionally we'd like to adapt a program slightly to our system or our needs. On locked disks, much of a software product's potential usage goes untapped. (Continued)

Letter Box (Continued)

But as publishers we've been drawn into the prevailing point of view that lack of copy protection means greatly decreased sales due to casual "piracy." This is not just a crazed overreaction; we've all been to user-group meetings, homes of acquaintances, and even some computer stores, where we've been aghast at the almost encouraging attitude toward copying copyrighted software, most of which took authors months, maybe years, to perfect. The real scare here is that many of us have decided to take a risk on a very new industry and trust our livelihoods to it. Suddenly, individuals out there become statistics, some of which say that for every non-protected program sold, there are at least a dozen "pirated" copies. Those kinds of numbers could really wreak havoc on paying the bills. Scary? Yes.

From these conflicting points of view, our desire to make a good product

better won, but not by much over our fear of tampering with something that is already going well. Our policies, from pricing to support, have always been very consumer-oriented. Ultimately, it is from that viewpoint that we decided to go ahead with removing the protection. We feel that you, the consumer, are entitled to software as useful as possible for the money you spend. Our hope is that the added convenience will result in more sales, not fewer, and that the software market has matured to the point where people realize that the result of illegal copying is less convenience for everyone with all software. We hope that people will think twice before accepting copies from friends, and we hope to be able to continue this policy and start a new trend toward improved usability of all applications software. Please don't abuse our trust in you.

Mark Pelczarski, President
Penguin Software
1206 Kings Circle
West Chicago, IL 60185

Dear Editor:

It would be extremely helpful if some of your readers could direct me to sources for two items: 1) a program in BASIC or machine language for OSI, Apple II, TRS-80, or PET, to score Gymnastics Meets; 2) a 16K dynamic RAM (4116) board to add to OSI Super-board II.


I have been looking for both of these for some time and have had no luck.

Bro. Felix Neussendorfer
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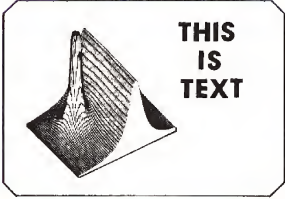
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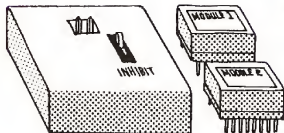
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MICRO — The 6502/6809 Journal

Memory Map Relocator

by Preston R. Black

This short program relocates a previous memory map program. Thus, even your longest program won't be written over by the memory map program.

MEMORY MAP Relocator requires: Apple II

The MEMORY MAP program by Peter Cook (MICRO 36:45) is a very elegant way to assess memory usage by the Apple II computer. I have found this program to be particularly useful as a tool in program development. It gives me an up-to-date account of the size of my program and the space reserved for variable storage.

One of the drawbacks of the program is its location in memory (\$3200). While this does not interfere with most of my programs, it is annoying to have to frequently reload a large program because parts of it have been written over by MEMORY MAP. This can be disastrous if the program you are developing has not been saved. Moreover, MEMORY MAP keeps reminding me that there is free space to use with my programs. Wouldn't it be great if MEMORY MAP were always loaded into that free space, leaving your program intact?

As Mr. Cook points out in his article, MEMORY MAP is not readily relocatable since there are frequent absolute references within the program. To relocate the program by hand would be most tedious. Obviously, a relocating loader for MEMORY MAP is what we need.

MEMORY MAP RELOCATOR is such a relocating loader. This program defines the free space in RAM and loads MEMORY MAP into that area. MEMORY MAP RELOCATOR then updates the relocated program to make it internally consistent and jumps to the beginning of the relocated program to run MEMORY MAP.

Memory Map Relocator

```
; *****
; *
; *
; *      MEMORY MAP RELOCATOR
; *      BY
; *      PRESTON R. BLACK MD
; *      MAY 1981
; *
; *
; *      THIS PROGRAM WILL RELOCATE
; *      THE MEMORY MAP PROGRAM
; *      WRITTEN BY PETER A. COOK
; *      (MICRO 36:45) TO RESIDE
; *      IN RAM WHERE THERE IS FREE
; *      SPACE AND WILL NOT WRITE
; *      OVER THE BASIC PROGRAM
; *      ALREADY IN MEMORY
; *
; *****
;
; EQUATES
;
NADDRL EPZ $06
NADDRH EPZ $07
NENDL  EPZ $08
NENDH  EPZ $09
BUFFL  EPZ $19
DIFF   EPZ $1B
BUFFH  EPZ $1C
LENGTH EPZ $2F
PROMPT EPZ $33
PGENDL EPZ $AF
PGENDH EPZ $B0
OLDADL EPZ $32
OLDADH EPZ $39
PGPTRL EPZ $CA
PGPTRH EPZ $CB
RSTPG3 EQU $9E25
RSTRTS EQU $9E30
INSDS2 EQU $F88E
COUT   EQU $FDED
;
; ORG $300
;
0300 4C1303 START JMP INIT
0303
0303 ; THIS ROUTINE RESTORES PAGE THREE DOS POINTERS
0303 ; WHICH ARE WRITTEN OVER BY THIS ROUTINE
0303
0303 A960 RSTORE LDA #$60 ; PLACE 'RTS' WHERE
0305 BD309E STA RSTRTS ; WE WANT IT BEFORE
0308 20259E JSR RSTPG3 ; WE JUMP TO RESTORE ROUTINE
030B
030B A9AD LDA #$AD ; RESTORE CHANGED DOS BYTE AND
030D BD309E STA RSTRTS ; JUMP TO RELOCATED MEMORY MAP
0310 6C1900 JMP (BUFFL)
0313
0313 ; THE TRUE BEGINNING OF THE PROGRAM
0313
0313 A533 INIT LDA $33 ; WHICH LANGUAGE?
0315 C9BE CMP #">" ; INTEGER BASIC?
0317 F00C BEQ INIT1
0319 E6B0 INC PGENDH ; NO, THEN ADD ONE TO H.O. BYTE
031B A5B0 LDA PGENDH ; APPLESOFT EOP POINTER
031D 8507 STA NADDRH ; TO MAKE SURE WE ARE OVER
031F 851A STA BUFFL+1 ; THE PROGRAM
0321 C6B0 DEC PGENDH
0323 D009 BNE INIT2
0325 38 SEC
0326 A5CB INIT1 LDA PGPTRH ; YES, USE INTEGER BASIC
0328 E90C SBC #$0C ; POINTERS
032A 8507 STA NADDRH ; ALLOW ENOUGH SPACE BELOW
; PROGRAM FOR MEMORY MAP
```

(Continued)

How it Works

The first step in relocating MEMORY MAP is to define the area of free space in RAM. Both Applesoft and Integer BASIC have pointers to the end of the program stored in memory. Unfortunately, they are not the same bytes. In addition, programs are not stored the same way in the two languages. Applesoft begins storing programs at \$801 and succeeding bytes are added above this. Integer BASIC begins storing programs at HIMEM and places all succeeding bytes below this. Thus, the pointers to the end of the program in the two languages must be treated differently.

For Applesoft we must load MEMORY MAP above the program already in memory. If we take the high order byte of the address of the end of the program and add one to it, we can be certain that we are above the program in memory. MEMORY MAP requires slightly less than \$C00 bytes of memory if we include the area used by the printing routine. Therefore, in Integer BASIC we must go at least this far below the program to load MEMORY MAP. Otherwise we will overwrite the BASIC program already in memory.

During initialization of MEMORY MAP RELOCATOR we can determine the current language by checking which prompt is used. Appropriate adjustments must be made to the high order byte of the program end. We now have a starting address within the free space to place MEMORY MAP. Calculate the ending address of the relocated program by adding the length of MEMORY MAP to the new starting address.

Next load MEMORY MAP into the free area. This is done by constructing a string consisting of "BLOAD MEMORY MAP,A\$xx00". The xx is the high order byte for the new starting address that we determined during initialization. But before we can place this number into our string, it must be converted into the ASCII representation of that number. This is done by first dividing the number into two nibbles (a nibble is equal to four bits) and converting the nibbles into the Apple ASCII code for the respective numbers. The Apple ASCII codes for the numbers from 0 to 9 are \$B0 to \$B9 respectively. Thus, to convert these numbers, we simply add \$B0 to them. (The numbers \$A to \$F must have \$B7 added to them to convert them into ASCII.) Once the numbers have been converted to ASCII, they are added to our string to complete it. We then use COUT (\$FDED) to pass the string to DOS to be executed.

Memory Map Relocator (Continued)

```

032C 851A      STA BUFFL+1
032E 18        INIT2 CLC
032F 6906      ADC #$06      ; FIND END OF
0331 8509      STA NENDH      ; RELOCATED PROGRAM
0333 851C      STA BUFFH      ; AND SAVE IN BUFFERS
0335 A9E0      LDA #$E0
0337 8508      STA NENDL
0339 A900      LDA #$00
033B 8506      STA NADDRL
033D 8519      STA BUFFL
033F A507      BLOAD LDA NADDRH      ; TAKE H.O. BYTE OF NEW START
0341 290F      AND #$0F      ; LOOK AT L.O. NIBBLE
0343 C90A      CMP #$0A      ; IS IT <10
0345 9006      BLT BLOAD1
0347 18        CLC
0349 69B7      ADC #$B7      ; NO, CONVERT TO ASCII
034A 4C5003     JMP BLOAD2      ; FOR 'A'-'F'
034D 18        CLC
034E 69B0      ADC #$B0      ; YES, CONVERT TO ASCII
                                ; FOR '0'-'9'
0350 A201      BLOAD2 LDX #$01
0352 9DF803     STA LOAD1,X      ; STORE IN STRING
0354 A507      LDA NADDRH
0356 4A        LSR
0358 4A        LSR
0359 4A        LSR
035A 4A        LSR
035B C90A      CMP #$0A
035D 9006      BLT BLOAD3
035F 18        CLC
0360 69B7      ADC #$B7
0362 4C6803     JMP BLOAD4
0365 18        CLC
0366 69B0      ADC #$B0
0368 CA        BLOAD4 DEX
0369 9DF803     STA LOAD1,X
036C BDE203     BLOAD5 LDA LOAD,X      ; USE COUT TO
036F F006      BEQ UPDATE      ; PASS BLOAD COMMAND TO
0371 20EFD      JSR COUT        ; DOS WITH RELOCATING
0373 E8        INX            ; STARTING ADDRESS
0375 D0F5      BNE BLOAD5
0377 38        UPDATE SEC
0378 A507      LDA NADDRH
037A E932      SBC #OLDADL
037C 851B      STA DIFF
037E A000      UPDAT1 LDY #$00
0380 B106      LDA (NADDRL),Y
0382 20BEFB     JSR INDS2
0385 A52F      LDA LENGTH
0387 AB        TAY
0388 C902      CMP #$02
038A D01D      BNE UPDAT3
038C B106      LDA (NADDRL),Y
038E C932      CMP #OLDADL
0390 9017      BLT UPDAT3
0392 C939      CMP #OLDADH
0394 B013      BGE UPDAT3
0396 C93B      CMP #OLDADH-1
0398 D008      BNE UPDAT2
039A B8        DEY
039B B106      LDA (NADDRL),Y
039D C8        INY
039E C9E0      CMP #$E0
03A0 B007      BGE UPDAT3
03A2 18        CLC
03A3 B106      LDA (NADDRL),Y
03A5 651B      ADC DIFF
03A7 9106      STA (NADDRL),Y
03A9 C8        UPDAT3 INY
03AA 98        TYA
03AB 18        CLC
03AC 6506      ADC NADDRL
03AE 8506      STA NADDRL
03B0 9002      BCC UPDAT4
03B2 E607      INC NADDRH
03B4 38        UPDAT4 SEC
03B5 A508      LDA NENDL
03B7 E506      SBC NADDRL
03B9 A509      LDA NENDH
03BB E507      SBC NADDRH
03BD 9003      BCC UPDAT5
03BF 4C7E03     JMP UPDAT1
03C2 A51C      UPDAT5 LDA BUFFH
03C4 A06F      LDY #$6F
03C6 9119      STA (BUFFL),Y
03C8           ;
03C8           ; NOW CORRECT THE ADDRESSES OF THE STARTING PAGES
03C8           ; FOR PRINTING THE MOVED TEXT PAGE
03C8           ;
03C8 A51C      LDA BUFFH
03CA 8509      STA NENDH
03CC A900      LDA #$00
03CE 8508      STA NENDL

```


Memory Map Relocator (Continued)

```

03D0 A0B3      LDY ##B3
03D2 1B        UPDAT6 CLC
03D3 B10B      LDA (NENDL),Y
03D5 651B      ADC DIFF
03D7 910B      STA (NENDL),Y
03D9 C8        INY
03DA C8        INY
03DB C0E0      CPY ##E0
03DD 90F3      BLT UPDAT6
03DF           ;
03DF           ; WHEN FINISHED RESTORE PAGE THREE POINTERS
03DF           ; BEFORE RUNNING RELOCATED MEMORY MAP
03DF           ;
03DF 4C0303     JMP RSTORE
03E2 8D8D84     LOAD  HEX 8D8D84
03E5 C2CCCF     ASC  "BLOAD MEMORY MAP,A*"
03E8 C1C4A0
03EB CDC5CD
03EE CFD2D9
03F1 A0CDC1
03F4 D0ACC1
03F7 A4
03FB 0000B0     LOAD1 HEX 0000B0B0D00
03FB B0BD00
03FE           LENTH EQU *-START

```

Once the program has been loaded into memory, we must update it to make internal calls consistent. The algorithm for this is as follows: First, the offset between the original program and the relocated program is calculated. This is the amount that must be added to the original addresses to make them compatible with the relocated program. Using the monitor routine INSDS2, we determine how many bytes are used by each op code. If the op code requires only one or two bytes, then any addressing will be relative and will not require updating. If, however,

the op code is three bytes long, then all addresses used must be absolute.

We must also check to see if that address is within the boundaries of the original program (i.e., from \$3200 to \$38E0). If it is, then we add the offset to the high order byte. If it is not, we go to the next op code. We continue in this fashion until we reach the end of the relocated program. When the relocated program has been completely updated, an indirect jump to the beginning of the relocated program will run MEMORY MAP.

How to Use the Program

MEMORY MAP RELOCATOR resides on page three of memory. Since it is longer than \$D0 bytes long, it overwrites important DOS vectors located on page three. To insure proper function of DOS after the program is run, a short routine to restore these pointers begins the program. It is placed at the beginning so it will not be destroyed while the pointers are restored.

The routine to restore the pointers makes use of the part of DOS which places the pointers onto page three during the bootstrap. I place an 'RTS' (\$60) in the place that suits my purposes and restore the byte to what it was before performing the indirect jump to run MEMORY MAP.

Once the program has been entered and saved, BRUNning it will place MEMORY MAP into the available free space and run it. Remember that this program is written to run with a program named MEMORY MAP which is normally stored from \$3200 to \$32E0. With minor modifications, this program can be converted to run with a program beginning at any address, and of any length.

Please contact Mr. Black at 16 Durham St., Boston, MA 02115.

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BASIC to Machine Language Interface

by Christer Engstrom

Since the AIM lacks a SYS or CALL function, it is difficult to communicate between BASIC and machine language. This interface routine makes the USR(W) function more flexible and allows entry of the machine language address directly in hexadecimal through the BASIC variable AD%.

Interface

requires:

AIM with 4K
BASIC
AIM Assembler

I own an AIM with 4K RAM and BASIC and assembler ROMs. The BASIC interpreter is slow, but the machine itself is very fast. Furthermore, there is a lack of cooperation between BASIC and machine language. The only way to jump out from BASIC to execute other code in memory, is to use the USR(W) command. This command lets you jump to a subroutine whose address is given in locations \$04 and \$05, and also pass a floating point value in locations \$B1 - \$B6.

A frequent use of this method results in many POKES, which are done byte-by-byte in decimal. This is not good for readability. I think we need an easier way to jump out, a better way to define where to jump, and a method to pass parameters. We need a general interface.

The best way to define an address is with (ASCII) hex characters. Here's my solution to the problem: every time BASIC executes the USR(W) command, the machine enters the general interface. The integer AD% is supposed to contain the address to jump to, in high-low order. The interface scans the variable table and searches for AD% (which in the machine is interpreted as \$C1C4 — ASCII of 'A' and 'D', each ORed with \$80). If it is found and contains an address > \$00FF, the interface converts the value W specified in the

USR(W) statement, to a signed binary value in locations \$AC to \$AD (subroutine \$BEFE).

Next it loads the byte at location \$AD (LSB of the value) into the accumulator, and jumps to the subroutine. On returning from the subroutine, the accumulator is stored into \$AD, and the signed binary value in \$AC-\$AD is converted back to the floating-point register (subroutine \$COD). Finally, a return to BASIC is made.

Examples

1. You want to jump to a subroutine at location \$0400.

```
10 AD% = X"0400"  
20 L = USR(0)
```

2. Take advantage of the monitor routine at location \$E97A. Don't forget that the accumulator must be loaded with a value:

```
10 AD% = X"E97A"  
20 L = USR(A)
```

I know, you're thinking that the X"0400" and the X"E97A" are not conforming to general BASIC syntax. But AD% = 1024 and AD% = -576 are! So what we now need is a way to translate all X".." expressions to their decimal equivalents before execution. That is done by the hex converter. If the general interface doesn't find AD% or if AD% is zero, all X".." and Z".." expressions are converted to decimal.

You can see that the hex converter is entered via the general interface. This means that it is easy to modify the interface so that it can execute more functions (with a function code in AD%). You may even want to modify the whole interface. Maybe it is better when used this way:

```
10 AD$ = "E97A"  
20 L = USR(A)
```

Let's get back to the hex converter. If you want to assign an unsigned value > \$7FFF to a BASIC Integer, you must consider this: the interval \$8000 to \$FFFF equals the decimal interval -32768 to -1. This means that \$8000 = -(\$10000 - \$8000) = -(65536 - 32768) = -32768.

We don't always want to translate the hex string to a signed value, so another type must be defined. This leads us to two different syntaxes. To get a signed decimal value, precede the hex string in quotes with an X. For positive (unsigned) values, use a Z instead.

Example 3:

```
X"9000" = -(65536 - 36864)  
          = -28672 BUT  
Z"9000" = 36864
```

If you define an address, use the X type. Note that only the program part, not the variable part, is hex-converted. Also note that the string within the quotes must consist only of the hex characters (0 - 9, A - F), and have a length of 0 - 4 characters. Left-fill with zeroes is done automatically. For example:

```
10 L = USR(X"A")  
20 A = X"CC"/B
```

After hex conversion,

```
10 L = USR(0010)  
20 A = 00204/B
```

no compression is done. The string beginning with X or Z is replaced by a decimal value of the same length. If the hex string is not enclosed within quotation marks, BASIC will attempt to interpret some strings to function codes during input phase; "DEF" for example.

Program Description: The Interface

In my version, the interface consists of two parts: the interface and the hex converter. Since only relative branches are made, both parts are relocatable. The interface and the hex conversion need

not cooperate — simply remove one of them. In my version, the interface must know the real start addresses of functions it should handle. The BASIC input buffer (\$14 - \$50) is used as a work area. The interface starts with a lookup of the variable table.

Here are some valuable points:

1. The start address for the table is in locations \$75 and \$76.
2. An integer variable name has \$80 added to the first and second character of its name (thus making AD% = \$C1C4, not \$4144).
3. Every entry in the table consists of seven bytes, the first two for its name.
4. An integer variable has its value (signed) in the two bytes following the name.
5. "End-of-table" is flagged by \$AA in the first location of an entry.

Here is a description of what is done at each label:

ENTRY—Stores the address of the variable table start in a work area.

SCAN—A search for \$C1C4 or end-of-table is done.

NEW—Get address for next entry, scan again.

CHECK—Tests value in leftmost byte of integer AD%.

JUMP—Jumps to subroutine after floating point conversion. At return, converts integer back to floating point array.

OUT—Clears A,X,Y registers and returns back to BASIC.

FUNC—Jumps to functions by testing the rightmost byte of AD%. Invalid functions are ignored.

FUNC.—The functions.

Hex Converter

This is a fairly long and space-consuming part; the readability is worth more than smart programming.

1. A scan for all strings beginning with X" and Z" is done in the program part (page "CHECK PROG").
2. If such a string is found, and the rest of it conforms to the above given

syntax, it is converted to the decimal equivalent (pages "MOVE RIGHT JUST" and "STRING TO HEX").

3. If it is an X" string with a value > = 32768, a sign-conversion (see example 3) is done (page "SIGN CONVERSION").
4. Finally, the converted value is edited back to the program (pages "EDIT NOW" and "MOVE TO PROG").
5. When the program part is scanned through, a return to the interface is done (page "MAIN LOOP").

Conclusion

We now have an extended and more flexible way to use BASIC with the rest of the machine. Even some monitor routines can be used without specially written routines. The hex converter allows us to specify constants in hexadecimal mode. This method also cooperates better with the rest of the machine. Finally, the interface can help during the editing of a program (function codes could be used).

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Listing 1: The Interface

```

;*****
;*
;*      BASIC INTERFACE
;*
;* BY CHRISTER ENGSTROM
;*
;*****
;
;      ORG $F81
ENTRY  LDX $75
;      STX $14
OF85 A676      LDX $76
OF87 8615      STX $15
OF89 A000      SCAN  LDY #$00
OF8B B114      LDA ($14),Y
OF8D C9AA      CMP #$AA
OF8F F051      BEQ FUNCO
OF91 C9C1      CMP #$C1
OF93 D007      BNE NEW
OF95 C8        INY
OF96 B114      LDA ($14),Y
OF98 C9C4      CMP #$C4
OF9A F010      BEQ CHECK
OF9C 18        NEW   CLC
OF9D A514      LDA $14
OF9F 6907      ADC #$07
OFA1 8514      STA $14
OFA3 A515      LDA $15
OFA5 6900      ADC #$00
OFA7 8515      STA $15
OFA9 18        CLC
OFAA 90DD      BCC SCAN
OFAC C8        CHECK INY
OFAD B114      LDA ($14),Y
OFAF F025      BEQ FUNC
OFB1 20FEFE    JUMP  JSR $BEFE
OFB4 A94C      LDA #$4C
OFB6 8516      STA $16
OFB8 A002      LDY #$02
OFBA B114      LDA ($14),Y
OFBC 8518      STA $18
OFBE C8        INY
OFBF B114      LDA ($14),Y
OFC1 8517      STA $17
OFC3 A5AD      LDA $AD
OFC5 201600    JSR $0016
OFC8 85AD      STA $AD
OFCA A5AC      LDA $AC
OFCC A4AD      LDY $AD
OFCE 20D1C0    JSR $COD1
OFD1 A900      OUT   LDA #$00
OFD3 A8        TAY
OFD4 AA        TAX
OFD5 60        RTS
OFD6 C8        FUNC  INY
OFD7 B114      LDA ($14),Y
OFD9 C900      CMP #$00
OFDB F005      BEQ FUNCO
OFDD C901      CMP #$01
OFDF F007      BEQ FUNCO
OFE1 60        RTS
OFE2 20000E    FUNC0 JSR $OE00
OFE5 18        CLC
OFE6 90E9      BCC OUT
OFE8 EA        FUNC1 NOP
OFE9 18        CLC
OFEA 90E5      BCC OUT

```

Listing 2: Hexadecimal Converter

```

;*****
;*
;*      HEX CONVERTER
;*
;* BY CHRISTER ENGSTROM
;*
;*****
;      ORG $OE00
START  LDA $73
;      STA $14
;      LDA $74
;      STA $15
;
;START LOOP IN PROG
;
LOOP   LDA $15
;      CMP $76
;      BMI GO
;      LDA $14
;      CMP $75
;      BMI GO
;      RTS
;
;      GO   JSR SUBR
;      CLC
;      LDA $14
;      ADC #$01
;      STA $14
;      LDA $15
;      ADC #$00
;      STA $15
;      CLC
;      BCC LOOP
;
;CHECK PROGRAM
;
SUBR   CLD
;      LDY #$00
;      LDA 'X'
;      CMP ($14),Y
;      BEQ CONT
;      LDA 'Z'
;      CMP ($14),Y
;      BNE NEXT
;
CONT   STA $16
;      LDA ""
;      INY
;      CMP ($14),Y
;      BNE NEXT
;      LDX '0'
;      STX $18
;      STX $19
;      STX $1A
;      STX $1B
;      LDX #$00
;      STX $34
;      LDX #$18
;      STX $33
;      NOP
;
;
IN     INY
;      LDA ($14),Y
;      CMP ""
;      BEQ UT
;      CPY #$06
;      BEQ NEXT

```

(Continued)

Listing 2 (Continued)

```

OE5E C930      CMP 'O
OE60 300C      BMI NEXT
OE62 C93A      CMP #$3A
OE64 30ED      BMI IN
OE66 C941      CMP 'A
OE68 3004      BMI NEXT
OE6A C947      CMP 'G
OE6C 30E5      BMI IN
OE6E           ;INVALID/NO STRING
OE6E 60        NEXT RTS
OE6F           ;
OE6F           ;MOVE RIGHT JUST
OE6F           ;
OE6F 8417      UT   STY $17
OE71 A203      LDX #$03
OE73 8636      STX $36
OE75 8435      STY $35
OE77 C635      IN2  DEC $35
OE79 A435      LDY $35
OE7B B114      LDA ($14),Y
OE7D C922      CMP ""
OE7F F009      BEQ UT2
OE81 A436      LDY $36
OE83 9133      STA ($33),Y
OE85 C636      DEC $36
OE87 18        CLC
OE88 90ED      BCC IN2
OE8A           ;
OE8A           ;STRING TO HEX
OE8A           ;
OE8A A003      UT2  LDY #$03
OE8C B133      UT2A LDA ($33),Y
OE8E 207DEF     JSR $EA7D
OE91 9133      STA ($33),Y
OE93 88        DEY

```

Listing 2 (Continued)

```

OE94 10F6      BPL UT2A
OE96           ;START COUNT LOOP
OE96 A200      LDX #$00
OE98 8622      STX $22
OE9A 8623      STX $23
OE9C 8624      STX $24
OE9E F8        SED
OE9F A940      LDA #$40
OEA1 8525      STA $25
OEA3 A996      LDA #$96
OEA5 8526      STA $26
OEA7 A518      LDA $18
OEA9           ;TEST BIT 1
OEA9 C908      CMP #$08
OEAB 300D      BMI NOMI
OEAD A516      LDA $16
OEAF C958      CMP 'X
OEB1 D007      RNE NOMI
OEB3 A9A5      LDA #$A5
OEB5           ;FLAG < 0
OEB5 8516      STA $16
OEB7 18        CLC
OEB8 9004      BCC IN3
OEBA A930      NOMI LDA '0
OEBE           ;FLAG >= 0
OEBE 8516      STA $16
OEBE C618      IN3  DEC $18
OEC0 3005      BMI UT3
OEC2 20F60E    JSR ADD
OEC5 90F7      BCC IN3
OEC7 A902      UT3  LDA #$02
OEC9 8525      STA $25
OECB A956      LDA #$56
OECD 8526      STA $26
OECF C619      IN4  DEC $19
OED1 3005      BMI UT4
OED3 20F60E    JSR ADD
OED6 90F7      BCC IN4
OED8 A900      UT4  LDA #$00
OEDA 8525      STA $25
OEDC A916      LDA #$16
OEDE 8526      STA $26
OEE0 C61A      IN5  DEC $1A
OEE2 3005      BMI UT5
OEE4 20F60E    JSR ADD
OEE7 90F7      BCC IN5
OEE9 A901      UT5  LDA #$01
OEEB 8526      STA $26
OEED C61B      IN6  DEC $1B
OEEF 301A      BMI UT6
OEF1 20F60E    JSR ADD
OEF4 90F7      BCC IN6
OEF6           ;ADD TO RESULT
OEF6 18        ADD CLC
OEF6           ;ADD TO RESULT
OEF7 A524      LDA $24
OEF9 6526      ADC $26
OEFB 8524      STA $24
Oefd A523      LDA $23
OEFF 6525      ADC $25
OF01 8523      STA $23
OF03 A522      LDA $22
OF05 6900      ADC #$00
OF07 8522      STA $22
OF09 18        CLC
OF0A 60        RTS
OF0B           ;
OF0B           ;SIGN CONVERSION

```

(Continued)

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Listing 2 (Continued)

| | |
|-------------|------------------|
| OF0B | |
| OF0B A516 | UT6 LDA \$16 |
| OF0D | ;CHECK MINUS |
| OF0D C9A5 | CMP #A5 |
| OF0F D013 | BNE IN7 |
| OF11 38 | SEC |
| OF12 A936 | LDA #36 |
| OF14 E524 | SBC \$24 |
| OF16 8524 | STA \$24 |
| OF18 A955 | LDA #55 |
| OF1A E523 | SBC \$23 |
| OF1C 8523 | STA \$23 |
| OF1E A906 | LDA #06 |
| OF20 E522 | SBC \$22 |
| OF22 8522 | STA \$22 |
| OF24 | |
| OF24 | ;EDIT NOW |
| OF24 | |
| OF24 D8 | IN7 CLD |
| OF25 EA | NOP |
| OF26 A516 | LDA \$16 |
| OF28 8535 | STA \$35 |
| OF2A A522 | LDA \$22 |
| OF2C 20560F | JSR LEFT |
| OF2F 8536 | STA \$36 |
| OF31 A522 | LDA \$22 |
| OF33 205C0F | JSR RIGHT |
| OF36 8537 | STA \$37 |
| OF38 A523 | LDA \$23 |
| OF3A 20560F | JSR LEFT |
| OF3D 8538 | STA \$38 |
| OF3F A523 | LDA \$23 |
| OF41 205C0F | JSR RIGHT |
| OF44 8539 | STA \$39 |
| OF46 A524 | LDA \$24 |
| OF48 20560F | JSR LEFT |
| OF4B 853A | STA \$3A |
| OF4D A524 | LDA \$24 |
| OF4F 205C0F | JSR RIGHT |
| OF52 853B | STA \$3B |
| OF54 9014 | BCC UT7 |
| OF56 29F0 | LEFT AND #F0 |
| OF58 6A | ROR |
| OF59 6A | ROR |
| OF5A 6A | ROR |
| OF5B 6A | ROR |
| OF5C 290F | RIGHT AND #0F |
| OF5E 18 | CLC |
| OF5F 6930 | ADC '0 |
| OF61 C93A | CMP #3A |
| OF63 1001 | BPL MORE |
| OF65 60 | RTS |
| OF66 6907 | MORE ADC #07 |
| OF68 18 | CLC |
| OF69 60 | RTS |
| OF6A | |
| OF6A | ;MOVE TO PROG |
| OF6A | |
| OF6A A935 | UT7 LDA #35 |
| OF6C 8533 | STA \$33 |
| OF6E A006 | LDY #06 |
| OF70 8416 | STY \$16 |
| OF72 B133 | IN8 LDA (\$33),Y |
| OF74 C616 | DEC \$16 |
| OF76 A417 | LDY \$17 |
| OF78 9114 | STA (\$14),Y |
| OF7A A416 | LDY \$16 |
| OF7C C617 | DEC \$17 |
| OF7E 10F2 | BPL IN8 |
| OF80 60 | RTS |

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Memory Moves with the 6502 and 6809

by Gregory Walker and Tom Whiteside

The authors demonstrate the advantages of the 6809's direct page addressing and 16-bit index registers with a comparison of 6502 and 6809 memory moves.

In a previous article (MICRO 47:57) we illustrated the advantages of programming the 6809 over the 6502 with a comparison of multiprecision arithmetic routines. We continue in this article with a comparison of the two processors' capabilities in solving memory move problems.

With these two articles, we hope to demonstrate that the MC6809 is not only faster and more byte-efficient than the 6502, but also more straightforward to program. Because the most useful kinds of 6502 indirect addressing must be done through page zero, it is important, particularly with larger operating systems, that page-zero RAM be used wisely. In addition, the 6502 index registers are only eight bits long, limiting indexing to a 256-byte range. These limitations will show themselves especially well in these memory move examples.

Memory moves have a number of practical applications, including word processing, EPROM programming, and program relocation. Similar techniques are involved with string manipulation and table searches.

Figure 1 is a 6502 memory move for fewer than 256 bytes from a fixed absolute address. This routine is not all that useful, since it can only work on two fixed pages due to the limited range of the 6502 index registers. However, it illustrates the real power of the 6502 in terms of byte efficiency and speed over small ranges of memory.

The program uses the fastest form of 6502 indirect addressing — absolute indexed. The Y register will be used

both as a loop index for the move and as a counter for the number of bytes to be moved. The Y register is initialized to the number of bytes to be moved and is decremented each time through the loop. When the Y register decrements to zero, the branch conditions are not met and the loop terminates. This use of the Y register eliminates the need for a CPY immediate instruction in the loop and speeds up the code. A "CNT" value of zero will move 256 bytes.

In these examples, the "LNG" column in figure 1 represents the number of bytes required per instruction. The "TIM" column is the number of machine cycles per instruction. The 6502 memory move for fewer than 256 bytes of memory required only 11 bytes of code and approximately 14 machine cycles per byte moved.

Figure 2 shows the same memory move written in MC6809 code. In this example, the 16-bit X register points to the "FROM" address and the U register points at the "TO" address. The MC6809 addressing mode used is indexed with accumulator offset. The effective address is formed by summing the two's complement contents of the B accumulator with the contents of the index register used. You will notice that the B accumulator is being used in the same manner as the 6502 Y register was in figure 3. Because the offset is two's complement, the MC6809 example is limited to 127 bytes. We included this example to show how similarly the two processors can be used to solve the same problem. The MC6809 took 15 bytes and 15 machine cycles per byte moved.

While the 6502 wins this round by four bytes and one machine cycle per

Figure 1: 6502 program to move fewer than 256 bytes of memory. Timing = $2 + 14 \cdot N$ where N is the number of bytes to move.

| | | (LNG TIM) | | |
|----------|-----------------|-----------|---|------------------------------------|
| LDY #CNT | | 2 | 2 | INITIALIZE THE BYTES TO MOVE COUNT |
| LOOP | LDA FROM - 1, Y | 3 | 4 | LOOP: GET BYTE TO MOVE |
| | STA TO - 1, Y | 3 | 5 | MOVE BYTE |
| | DEY | 1 | 2 | DECREMENT LOOP COUNTER |
| | BNE LOOP | 2 | 3 | LOOP UNTIL ZERO COUNT |
| | | 11 | | |

Figure 2: MC6809 program to move fewer than 128 bytes of memory. Timing = $8 + 15 \cdot N$.

| | | | | |
|------|---------------|----|---|--------------------------------|
| | LDX #FROM - 1 | 3 | 3 | INITIALIZE "FROM" POINTER |
| | LDU #TO - 1 | 3 | 3 | INITIALIZE "TO" POINTER |
| | LDB #CNT | 2 | 2 | INITIALIZE BYTES TO MOVE COUNT |
| LOOP | LDA B, X | 2 | 5 | LOOP: GET BYTE |
| | STA B, U | 2 | 5 | AND MOVE IT |
| | DECB | 1 | 2 | DECREMENT LOOP COUNT |
| | BNE LOOP | 2 | 3 | LOOP UNTIL COUNT IS ZERO |
| | | 15 | | |

byte over the MC6809, the MC6809 code is more versatile. If this were a subroutine, "LOOP" could be called with X and U pointing anywhere in memory, while the 6502 example would be limited to the 256-byte range of its index registers. Because the MC6809 code holds the pointers in registers instead of memory locations, it is re-entrant and could be used in a real-time operating system.

Since it appears that the 6502 can keep up with the MC6809 on a short memory move, let's try another memory move. This time the code must be able to move *any* number of bytes. A real measure of a processor's power is how much its performance degrades as the complexity of its task increases. In this example, complexity is measured in terms of address range.

Figure 3 shows a 6502 program to move any size block of memory. "CNT" bytes will be moved from address "FROM" to address "TO". The bytes will be moved starting at address "FROM" plus "CNT," with "CNT" decremented each time through the loop. Since the 6502 index registers are only eight bits wide, it is necessary to use indirect indexed addressing to move more than 256 bytes. (We do not count self-modifying code as an option, but as an abomination!)

The first part of the program sets up the two 16-bit zero-page pointers "FROM" and "TO". "CNT" is a 16-bit number stored in the X register (least significant byte) and "COUNT" (most significant byte). The X register is used to store the least significant byte of "CNT" to save three machine cycles per byte moved over using a zero-page variable. The "CNT" most significant byte is initialized to one count higher than desired to eliminate the need for a load/compare step that would have used time and bytes. The pointer least significant bytes are incremented rather than the Y register, since the "FROM" and "TO" least significant bytes might not be the same.

If the above "tricks" seem confusing to you, you are not alone. Tricks cost money in terms of debug time and the time required to recode the routine when some performance requirement is changed. However, we tried to write the best 6502 code possible. The result is typical of commercial practice. Even with all these tricks, the 6502 code was 47 bytes long and approximately 32 machine cycles per byte. This is more than four times the size, and twice the cycles per byte over the short memory move. Now you see what we meant about performance degradation with increased task complexity!

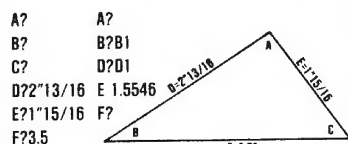
Figures 4 and 5 show two versions of MC6809 memory moves which can handle memory ranges of more than 256 bytes. Both examples are identical except that one (figure 4) moves memory one byte at a time while the other (figure 5) moves two bytes at once. Both require 18 bytes of code, but the second program is eight machine cycles per byte (40%!) faster than the first.

In both these programs, the X register acts as a pointer to the "FROM" address and the U register acts as a pointer to the "TO" address, just like the program in figure 2. In these routines, however, the index registers are incremented each time through the loop as indicated by the "+" beside the indexed loads and stores. Since the second program moves two bytes at a time, the MC6809 double increment ("++") mode is used to advance to the next word. In both figures, the Y register is a counter to the number of bytes remaining to be counted. The "LEAY" instruction has no 6502 equivalent and indicates that the Y register is to be loaded with the "effective" address indicated in the operand field. In figure 4, the operand field of the LEAY instruction means to load Y with the contents of Y minus 1 like a 16-bit 6502 "DEY".

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Figure 3: 6502 program to move any number of bytes of memory. Timing = 31 + (35 + 28/256) * N.

| | (LNG | TIM) | |
|--------------------|------|------|--------------------------------|
| LDA #FROML | 2 | 2 | INITIALIZE INDIRECT "FROM" PTR |
| STA FROM | 2 | 4 | |
| LDA #FROMH | 2 | 2 | |
| STA FROM+1 | 2 | 4 | |
| LDA #TOL | 2 | 2 | INITIALIZE INDIRECT "TO" PTR |
| STA TO | 2 | 3 | |
| LDA #TOH | 2 | 2 | |
| STA TO+1 | 2 | 3 | |
| LDA #CNTH+1 | 2 | 2 | INIT BYTES TO MOVE COUNT MSB |
| STA COUNT | 2 | 3 | TO (COUNT / 256) + 1 |
| LDX #CNTL+1 | 2 | 2 | INIT X TO THE COUNT LSB |
| LDY #0 | 2 | 2 | INITIALIZE INDIRECT POINTER |
| LOOP LDA [FROM], Y | 2 | 5 | LOOP: GET A BYTE |
| STA [TO], Y | 2 | 6 | AND MOVE IT |
| INC TO | 2 | 5 | INCREMENT 16-BIT "TO" |
| BNE NOINC1 | 2 | 4 | POINTER |
| INC TO+1 | 2 | 5 | |
| NOINC1 INC FROM | 2 | 5 | INCREMENT 16-BIT "FROM" |
| BNE NOINC2 | 2 | 4 | POINTER |
| INC FROM+1 | 2 | 5 | |
| NIINC2 DEX | 1 | 2 | DECREMENT 16-BIT "CNT" |
| BNE LOOP | 2 | 4 | |
| DEC COUNT | 2 | 5 | |
| BNE LOOP | 2 | 4 | LOOP UNTIL "CNT" IS ZERO |
| | 47 | | |

Figure 4: MC6809 program to move any length of memory. Timing = $10 + 20 \cdot N$.

| | | (LNG | TIM) | |
|------|------------|------|------|----------------------------------|
| | LDX #FROM | 3 | 3 | INITIALIZE 16-BIT "FROM" POINTER |
| | LDU #TO | 3 | 3 | INITIALIZE 16-BIT "TO" POINTER |
| | LDY #CNT | 4 | 4 | INITIALIZE BYTES TO MOVE COUNT |
| LOOP | LDA , X + | 2 | 6 | LOOP: GET BYTE TO MOVE; BUMP |
| | STA , U + | 2 | 6 | POINTER; MOVE WORD; BUMP |
| | LEAY -1, Y | 2 | 5 | POINTER; DECREMENT COUNT |
| | BNE LOOP | 2 | 3 | BY ONE UNTIL COUNT IS ZERO |
| | | 18 | | |

Figure 5: MC6809 program to move any length of memory. Timing = $10 + 12 \cdot N$.

| | | (LNG | TIM) | |
|------|-------------|------|------|----------------------------------|
| | LDX #FROM | 3 | 3 | INITIALIZE 16-BIT "FROM" POINTER |
| | LDU #TO | 3 | 3 | INITIALIZE 16-BIT "TO" POINTER |
| | LDY #CNT | 4 | 4 | INITIALIZE BYTES TO MOVE COUNT |
| LOOP | LDD , X + + | 2 | 8 | LOOP: GET WORD TO MOVE; BUMP |
| | STD , U + + | 2 | 8 | POINTER; MOVE WORD; BUMP |
| | LEAY -2, Y | 2 | 5 | POINTER + 2; DECREMENT |
| | BNE LOOP | 2 | 3 | COUNT BY TWO UNTIL COUNT IS ZERO |
| | | 18 | | |

Since the second program moves words, Y gets decremented with the contents of Y minus 2.

The program in figure 6 combines the code from figures 4 and 5 to produce a fast, general-purpose memory move for the MC6809 which moves any number of bytes, a word (two bytes) at a time. This routine uses the powerful double-byte move code of figure 5, only without the even-byte restriction. The way this is achieved is straightforward. The "CNT" word is tested for odd length by first using the "TFR" instruction to move the "CNT" to the D register. This is followed by a "LSRB" (logical shift right B) which sets the carry bit if "CNT" is odd. If the length is even, the routine branches directly to the double-byte move routine. Otherwise, the "odd" byte is moved first using the figure 2 code. This routine is 29 bytes long and takes approximately 12 machine cycles per byte moved. The general purpose routine takes almost twice the bytes of the MC6809 short move but requires 20% less time per byte!

Figure 7 summarizes the results for the memory moves discussed in figures 1 through 6. The byte ratio column is the number of 6502 bytes divided by the MC6809 bytes for a given comparison. The cycles per byte ratio column is the 6502 cycles required, per byte moved, divided by the MC6809 cycles per byte. For example, the row labeled " ≤ 256 bytes" shows that the 6502 program from figure 1 used 11 bytes and needed about 14 cycles per byte moved. The MC6809 program in figure 2 needed 15 bytes and used 15 cycles per byte moved. The "byte ratio" is then $11/15$ or 0.73. The "cycles per byte ratio" is $14/15$ or 0.93.

As the table in figure 7 shows, the 6502 is good at moving small blocks of memory with fixed addressing. The MC6809 code for a move of fewer than 256 bytes comes close to keeping up with the 6502, but requires over a third more bytes. Our general-purpose double-byte move routine is slightly faster than the 6502 but is much more costly in terms of bytes. Since the MC6809 general purpose routine is

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Figure 6: General MC6809 program to move any length of memory. Timing = 41 + 12 * N.

| | (LNG TIM) | |
|---------------|-----------|---|
| LDX #FROM | 3 3 | INITIALIZE "FROM" POINTER |
| LDU #TO | 3 3 | INITIALIZE "TO" POINTER |
| LDY #CNT | 4 4 | INITIALIZE BYTES TO MOVE COUNT |
| | | |
| TFR Y, D | 2 6 | CHECK FOR ODD COUNT |
| LSRB | 1 2 | MOVE COUNT LSB TO B REGISTER; SET CARRY IF COUNT IS ODD; TO LOOP IF COUNT IS EVEN |
| BCC LOOP | 2 3 | |
| | | |
| LDA ,X+ | 2 6 | ELSE GET ODD BYTE; BUMP POINTER; MOVE IT; BUMP |
| STA ,U+ | 2 6 | POINTER; DECREMENT LOOP COUNT; QUIT COUNT IS ZERO |
| LEAY -1, Y | 2 5 | |
| BEQ DONE | 2 3 | |
| | | |
| LOOP LDD ,X++ | 2 8 | LOOP: GET NEXT WORD; BUMP |
| STD ,U++ | 2 8 | POINTER+2; MOVE IT; BUMP |
| LEAY -2, Y | 2 5 | POINTER+2; DECREMENT LOOP COUNT BY TWO UNTIL COUNT IS ZERO |
| BNE LOOP | 2 3 | |
| | | |
| DONE EQU * | | |

29

Figure 7: 6502/MC6809 byte and cycles per byte ratios for figures 1 through 6.

| Class of Move | Byte Ratio | Cycles/Byte Ratio |
|---------------------------|----------------|-------------------|
| < = 256 bytes | | |
| 6502-Fig 1 / MC6809-Fig 2 | 11 / 15 = 0.73 | 14 / 15 = 0.93 |
| 6502-Fig 1 / MC6809-Fig 6 | 11 / 29 = 0.38 | 14 / 12 = 1.17 |
| > 256 bytes | | |
| 6502-Fig 3 / MC6809-Fig 4 | 47 / 18 = 2.61 | 35 / 20 = 1.75 |
| 6502-Fig 3 / MC6809-Fig 5 | 47 / 18 = 2.61 | 35 / 12 = 2.92 |
| 6502-Fig 3 / MC6809-Fig 6 | 47 / 29 = 1.62 | 35 / 12 = 2.92 |

easily made into a subroutine, the extra byte cost might be lessened by sharing the code with other parts of a program. The 6502 code example lacks this versatility since it is limited to fixed 256 byte ranges.

The more complex memory move of more than 256 bytes is where the MC6809 really asserts itself. MC6809 versions were presented for a single byte move, an even-length-only double-byte move, and a general-purpose "any length" move. For "byte tight" applications, the MC6809 byte mover runs 1.75 times faster than the 6502, while the 6502 uses 2.6 times the bytes of the MC6809. While the MC6809 double-byte mover from figure 5 is restricted to even-byte moves only, it rips along at almost three times the rate of the 6502 with no more code than the single-byte version.

The MC6809 general-purpose double-byte mover (figure 6) maintains the blazing speed of figure 5 without being restricted to even-byte moves. The 6502 move uses 1.6 times the bytes of the MC6809 general purpose mover.

These results show clearly the degradation of speed and code size of the 6502 for memory moves across page boundaries. We feel that the MC6809 has also been easier to program. There has been no need to set up and manipulate indirect pointers with registers of only eight bits, as was necessary on the long 6502 memory move.

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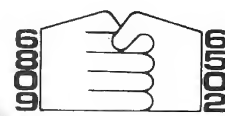
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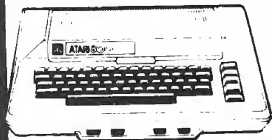
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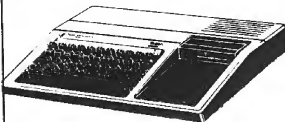
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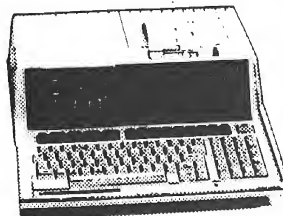
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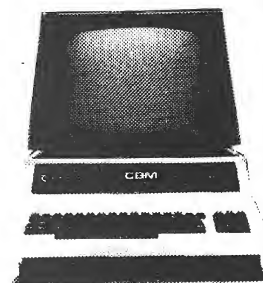
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PET Vet

By Loren Wright

PET's Powerful Screen Editing — Are you getting the most from it?

When it comes to BASIC programming, most computers employ what I call a 'teletype' mentality. You type in the line number, followed by the line contents. Then you send all the characters you typed to the computer by pressing the RETURN key. Before you hit RETURN, you can correct errors by deleting back to the error, making the correction, and then retyping the rest of the line. If you have made the mistake of hitting RETURN before you notice the error, the only way to correct it is to start over. The characters you just typed in are still sitting there on the screen, but you can't do anything with them. The computer has forgotten all about what you typed. Sure, there's a copy in your BASIC program, and you can list the line to the screen, but you can't do anything with that either. Some of these computers allow some primitive editing — if you can remember the obscure control codes and are willing to copy characters back into memory. It is usually faster to retype your BASIC line.

The PET BASIC input works quite differently. Instead of keeping track of the stream of characters you're typing, the PET just puts them up on the screen. You can move the cursor anywhere you want, draw pictures, check your disk directory, or list another line. All that counts is where the cursor is when you hit RETURN. If it's on a line that begins with a number, then the system reads the line as a BASIC statement. If the line doesn't begin with a number and the line isn't a valid direct command, then the PET will respond with a ?SYNTAX ERROR.

This system offers a lot of advantages to the PET BASIC programmer. To correct an error in the line you're typing, all you have to do is move the cursor, make the correction, move the cursor back to the end of the line, and continue typing. If you want to correct a line you've already entered into the program, just list it to the screen (if it isn't already there), make the correction, and hit RETURN with the cursor anywhere on the line to enter the new version.

Tricks of the Trade

It seems simple enough, doesn't it? If you have never tried to write a BASIC program on another computer, you probably take it all for granted. There are, however, a few traps you can fall into, and there are a few little tricks you can use to make the system work even better.

1. Clear the screen before you list lines you're going to edit. If you don't, garbage left over from your program run will appear on the same lines as your BASIC lines and those characters will be put into memory when you hit RETURN.
2. The cursor does not have to be at the end of the line when you hit RETURN. As soon as you have completed your change, you can hit RETURN.
3. If you're at the left end of a line and you want to be at the right end, the fastest way to get there is not to go forward, but rather to back up to the end of the previous line and move down one line. If you're at the right end and you want to be at the left, then the opposite holds true.
4. Don't forget the HOME key! If you're at the bottom of the screen, it's much faster to hit HOME than to move the cursor up all those lines.
5. Shifted RETURN is not the same as RETURN! It will move the cursor to the beginning of the next line, but it will not send the line to the PET for processing.
6. If you need to move a line to make room for others, just list it, change the number and hit RETURN. Remember, though, that the old copy is still there at the old number until you delete it or replace it. This technique is also particularly handy when you are writing a program that is very repetitive (e.g., a series of subroutines, where several lines are identical in each routine). Just type the line once, and for each copy, change the line number and hit RETURN.
7. If a listed line exceeds two lines, the overflow is not considered as part of the line when you try to re-enter it. This happens because you used abbreviations for BASIC keywords (like '?' for PRINT) when you originally entered the line. Using the keyword abbreviations is fine, but try to avoid using such long lines.
8. Be careful with BASIC lines that occupy only one screen line. Under some circumstances it is possible to get the next line listed on the screen entered as part of your current line. The cure is to list only one such line at a time.
9. Use the screen as a temporary storage device! This one takes some care. Let's say you have just typed in 30 lines, and you suddenly decide that only eight of them are good. You could delete each unwanted line by typing its number, but it is faster to list the lines you want to save, type NEW and RETURN. Then position the cursor on the first line, hit RETURN, and keep hitting RETURN until all the lines are restored. If any of them scroll off the screen before you re-enter them, they will have to be retyped.

Most of these tricks work fine for direct commands, too. For instance, if you misspell the file name in a LOAD command, just stop the search, move the cursor to the command line, make the change, and hit RETURN.

Programmed Cursor Mode

Another powerful feature of the PET is its character-programmable cursor commands. Cursor moves can be included as special characters in a BASIC string so that when the string is printed, the cursor moves are executed. To get these characters into the string, the PET has something called "programmed cursor mode," where pressing a cursor key causes the appropriate special character to appear on the screen instead of the cursor move itself. The programmer loses control of the cursor while in programmed cursor mode (PCM), and if you don't know what's going on, it's easy to get

PET VET (Continued)

frustrated. PCM is entered under only two circumstances:

1. When you type a double quote, you enter PCM; when you type another, you exit. The PET keeps track of the number of quotes in a line, but it can be fooled.
2. When you use the INSERT key, the PET counts the number of times you press it, and for that number of characters it is in PCM. The assumption is that most insertions will be within strings.

Quite often you want to be in PCM when the PET isn't, and *vice versa*. To get in or out, just type a quote and then delete it if you don't need it. The PET only recognizes when you type quotes, not when you delete them! If you've done an insertion, just type spaces for the number of characters you inserted and you will regain control of the cursor. The spaces can then be deleted.

In other instances, things get completely out of hand and you just want to start over. The answer is shift-

RETURN! It will bail you out of PCM and it will preserve the original version of the line you're editing.

It also helps to know what the cursor control characters look like when they're included in strings. This depends both on which model PET you have and on which character set you're in. A few experiments, and perhaps a little crib sheet taped to your PET will help.

Editing Improvements

If you do a lot of BASIC programming even these powerful features may not be enough. Autonumber, renumber, delete functions, and repeating keys are probably the most useful enhancements. List scrolling and programmable function key capability are also useful. These functions are available in a number of commercial ROMs, such as Programmer's Toolkit, Disk-O-Pro, Command-O, POWER, EZAID, and others. Not all offer all of these editing features, but all include other capabilities.

Fat 40, 8000 Series, and VIC

These recent Commodore machines incorporate repeating keys and an ES-

CAPE key to get out of programmed cursor mode. The 8000 series computers have additional special characters for window, delete line, insert line, scrolling and other commands. The VIC has special characters for color commands and its eight programmable function keys.

Commodore's New Computers

With three new computers added to its existing line, Commodore will have an iron in just about every part of the microcomputer fire. The Ultimax (\$149.95) is a color-and-sound computer that hooks up to any home TV set. It will compete very favorably with the Sinclair ZX-81, Mattel Intellivision, and Atari VCS. The Ultimax will support joysticks, paddles, light pens, cartridges, and cassette storage. To achieve such a low price, Commodore has provided only a limited amount of RAM and a flat membrane keyboard.

The Commodore-64 (\$599) is designed to compete with the Atari 800 and Apple II with its full-size keyboard, 64K of memory, function keys, and sophisticated sound capabilities. Also announced was a 16K VIC — the SuperVIC.

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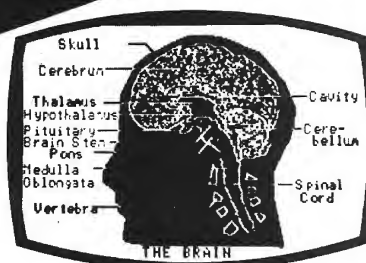
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From Here to Atari

By James Capparell

Editor's Note: This is the last "From Here to Atari" that will appear in MICRO. We thank Jim Capparell for his efforts and wish him success with his new Atari magazine, ANTIC. And we say to the Atari Community: send us your work! We are very interested in publishing Atari material.

The "front jacks" on the Atari 400 and 800 are used for everything from game controller ports to printer and graphics ports. To get the most out of them it is necessary to understand something about the hardware. This month, I'll provide a description of the pin configuration of these jacks, the memory locations assigned to the jacks, and an example of how each pin may be individually configured as input or output.

The hardware controlling these jacks is a 6820 PIA (Peripheral Interface Adapter). This chip consists of two ports labeled "A" and "B". Port A controls Jacks 1 and 2. Jacks 3 and 4 (on your right) are controlled by Port B. The jacks are numbered left to right as you face the console. There is a numbering discrepancy: BASIC numbers them 0 to 3. The BASIC statement,

```
10?STICK(0),STICK(1),STICK(2),STICK(3)
```

will print the values read at Jack 1, Jack 2, Jack 3, and Jack 4.

Each port consists of three registers — the Control Register, the Data Direction Register (DDR), and the Data (buffer) Register (DR). The PIA is a 40-pin chip. Due to a limitation on available pins, the DDR and the DR share the same address. (See table 1.)

Bit 2 of the control registers determines whether the DDR or the DR is addressed. When set to 0, bit 2 addresses the DDR, but when set to 1 the DR is addressed. The data register simply holds data. When the jacks are configured as input ports, the DR holds the data for the Atari to read.

When the jacks are configured as output ports, the DR holds data to be written to an external device. The DDR determines for the PIA which lines are input and which are output.

To configure Jack 1 as input and Jack 2 as output, it is necessary to tell the PIA the direction for each of the eight bits in Port A. To accomplish this, perform the following steps:

1. Set bit 2 of PACTL(\$D302) to 0. This allows us to address the DDR.
2. Write 00001111 = 15 to address \$D300 (note a 1 bit indicates the associated line is output).
3. Set bit 2 of PACTL to 1. This restores address \$D300 to the data register.

At this point, Jack 1 can be read normally with a STICK(0) statement. Jack 2 can't be read since it is configured as an output jack. Try the following:

```
10 POKE 54018,0 :REM Go talk to
   Data Direction Register
20 POKE 54016,15 :REM Jack 1 is input,
   Jack 2 is output
30 POKE 54018,4 :REM Reset to data
   register
40 REM connect joystick to Jacks 1 and 2
50 ?STICK(0),STICK(1) :REM Print out
   values from Jacks 1 and 2
60 GOTO 50 :REM Loop forever
70 REM Move Joysticks 1 and 2, only
   Joystick 1 will register a change.
```

Whenever your system is turned on all jacks are configured as input. That is, the operating system writes a 0 to the Data Direction Registers in Ports A and B. The values returned at these jacks are always a 1 when there is no input — logical 1 is false. This helps explain why a 15 is read even when there is no

Table 1

| I/O Address | O.S. Shadow Address |
|----------------|---------------------|
| \$D300 (54016) | \$278 (632) |

Port A data register or data direction register when bit 2 of PACTL is 0. This address corresponds with Jack 1 and Jack 2. BASIC statements STICK(0) and STICK(1) read this port.

| | |
|----------------|-------------|
| \$D301 (54017) | \$279 (633) |
|----------------|-------------|

Port B data register or data direction register when bit 2 of PBCTL is 0. This address corresponds with Jack 3 and Jack 4. BASIC statements STICK(2) and STICK(3) read this port.

| | |
|----------------|-------------|
| \$D302 (54018) | \$27A (634) |
|----------------|-------------|

Port A control register. Insert a value of 4 (bit 2 = 1) and \$D300 becomes the Data Register.

| | |
|----------------|-------------|
| \$D303 (54019) | \$27B (635) |
|----------------|-------------|

Port B control register. Insert a value of 4 (bit 2 = 1) and \$D301 becomes the Data Register.

The shadow registers are updated at Stage 2 of Vertical blank processing — no more frequently than every 1/60 second. If your program requires more accurate data, read the associated hardware registers at addresses \$D300 and \$D301.

From Here To Atari *(Continued)*

input from a joystick. Look at the diagram in figure 1 for correspondences between bits in DDR and bits in data buffer.

When a jack is configured to input and the following BASIC statement is executed:

```
10 ?STICK(0):GOTO 10
```

the following values will be printed as the joystick is manipulated:

```
1111 (15) = stick neutral
1110 (14) = forward
1101 (13) = backward
1011 (12) = left
0111 (11) = right
```

Combinations (diagonal)

```
1010 (10) = forward/left
1001 (9)  = backward/left
0101 (7)  = backward/right
0110 (6)  = forward/right
```

The pin configuration for each jack is as follows:

| | | | | | |
|--|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| | 6 | 7 | 8 | 9 | |

Console (male)

Pin 1 = forward
Pin 2 = backward
Pin 3 = left
Pin 4 = right

Pin 5 = pot (paddle control)
Pin 6 = joystick trigger at \$D010-\$D013 (CTIA)
Pin 7 = +5V
Pin 8 = gnd
Pin 9 = pot (paddle control)

These front jacks are versatile and easy to use. I've connected a Hewlett Packard Bar code reader to my 800. Others have used them for graphics printer interface and 10-key pad for business use as well.

Joystick Data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|

Jack 2 Jack 1
(stick 1) (stick 0)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|

Data Direction Register

When bit = 0 then switch pressed
bit = 1 then switch not pressed

Bit 0, 4 = Forward
 1, 5 = Backward
 2, 6 = Left
 3, 7 = Right

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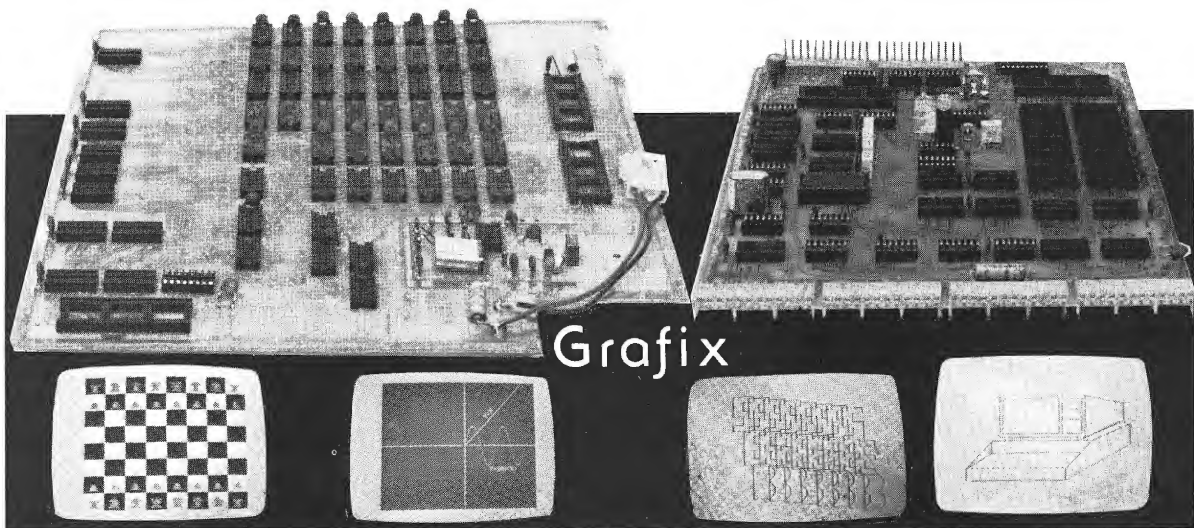
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Reviews in Brief

Product Name: **Mittendorf High-Resolution Graphics Board**
Equip. req'd: OSI
Price: \$40 bare board, \$185 kit
Manufacturer: Mittendorf Engineering
905 Villa Nueva Dr.
Litchfield Park, AZ 85340

Description: A 6" x 6" circuit board which adds 256 x 256 black and white high-resolution graphics to OSI systems. The same kit works with the superbboard or 540 video board. The Mittendorf board contains 8K of 2114 memory which can be used for program storage when not using graphics.

Pluses: Combines with the present video signal to give hi-res graphics and the OSI character set on the same monitor. The graphics memory can be wired at one of several addresses.

Minuses: The Mittendorf board requires 16 connections into the OSI video circuits. The 540 version requires additional jumpers to all the bus lines. The superbboard version requires removal of the data buffers which prevents further use of the 40-pin expansion port. All 256 x 256 dots are not visible. Dots are lost to overscan in the same ratio that are lost from OSI's nominal "32 x 32" characters.

Documentation: Several sets of construction plans dependent on system, software to add graphics commands to BASIC, demonstration examples.

Skill level required: Experienced builder; modification of present video circuits required.

Reviewer: Earl D. Morris

Product Name: **Visiterm**
Equip. req'd: Apple II or Apple II Plus and communications device: Apple Communications card, CCS card plus modem or D.C. Hayes Micromodem
Price: \$149.95
Manufacturer: Personal Software Inc.
1330 Bordeaux Drive
Sunnyvale, CA 94086
(408) 745-7841
Author: Tom Keith
Copy Protection: Yes
Language: 6502 Machine Language

Description: A communication package for interfacing the Apple with other computers, permitting the transfer and receipt of sequential text files.

Pluses: Visiterm uses one of two high-resolution character sets and the hi-res screen to provide the Apple user with a seventy-column display when communicating with other systems. This feature is particularly valuable when accessing a mainframe computer since up to eighty columns are often transmitted to the user. The character sets are programmable, permitting the user the valuable resource of redefining keys to permit the generation of mainframe-dependent control characters. One of the most technically

challenging aspects of using a micro as an intelligent terminal is the problem of required control keys such as the Break and X-on and X-off signals. The very extensive manual contains a thorough discussion of data communications. The main part of the manual contains almost 100 pages. The appendices, glossary, and detailed index contain almost as many pages. A print utility is provided that allows the user to obtain a hard copy of received data. The utility has many useful options which permit printer control and output formatting. A very powerful package with features useful for more than just communications.

Minuses: One limitation is that only sequential text files can be exchanged. However, stand-alone utility programs, outside of Visiterm, are provided to convert BASIC and binary files to and from text files. Visiterm does not provide the user with the ability to edit the data buffer exchanged. A separate text file editor may be needed by the user. (This is mentioned because at least one competing package does provide this feature.) An abbreviated summary of the Visiterm options would be helpful. For those familiar with VisiCalc II, also manufactured by Personal Software, a flow chart of commands is included which provides the user an excellent reference. It is sometimes difficult to locate the discussion of a particular topic. For example, it is possible to obtain a CATALOG of text files on a disk from within Visiterm. However, the section describing this is found under lesson Three, "File Transfer Mode." You may find it necessary to read most of the three lessons provided before you are comfortable using the package.

Skill level required: For the moderately sophisticated user, preferably with some understanding of communications problems.

Reviewer: David R. Morganstein

Product Name: **A2-3D1, A2-3D2 and A2-GE1 Graphics Package**
Equip. req'd: 48K Apple II or Apple II with disk drive
Price: \$119.85
Manufacturer: SubLogic Communications Corp.
713 Edgebrook Drive
Champaign, IL

Description: Programs to help the user produce, project, and maneuver three-dimensional shapes on the two-dimensional screen medium. Contains impressive features for recording motion sequences and replaying them. Individual snapshots or slides of a motion sequence can also be recorded for later display. Provision is made for interfacing routines to Applesoft programs.

Pluses: Either eye or object movement can be commanded, thereby adding flexibility to sequence definition. Exceptional ease in interfacing to BASIC programs.

Minuses: Extensive memory and disk space is required. The included demo disk inadequately demonstrates the

(Continued on next page)

Reviews in Brief *(Continued)*

package's considerable capabilities. The potential buyer should be aware of this and not underjudge the product.

Documentation: Superb documentation leads the user through a continuing example that eventually opens a 3-D garage door. Along the way, all capabilities are presented and an example of each is given. Surprisingly well-written in a style that lends itself to use as a tutorial or a reference.

Skill level required: Competent BASIC programmer with some exposure to assembly language.

Reviewer: Chris Williams

Product Name: **56K CMOS Static Memory Board**
Equip. req'd: OSI 48-pin bus
Price: 4K \$200; 24K \$450; 56K \$850
Manufacturer: Micro-Interface
3111 So. Valley View Blvd.
Suite I-101
Las Vegas, Nevada 89102

Description: The Micro-Interface board puts 56K of memory, an expanded monitor ROM and a parallel printer port all into a single bus slot. The board enable can be set at each 2K address selection, allowing any combination of 6116 CMOS RAM and/or 2716 EPROM to populate any portion of the 56K memory space. The use of CMOS RAM reduces the power requirements for 48K to less than ½ amp, allowing memory expansion without a new power supply. Decoding is also provided for a 1.75K enhanced ROM monitor between \$F800 and \$FFFF. Micro-Interface sells several such monitors, or you can program your own into a 2716 EPROM.

Pluses: Very low power RAM rated for 2 MHz operation. Combines functions of several boards into one bus slot. Provision is made for multi-user or memory banking. The parallel port supports either a 6821 PIA or 6522 VIA. The board is available assembled with any amount of memory between 4K and 56K. Additional memory chips are easily installed.

Minuses: For 8/16/24K the Micro-Interface board is more expensive than the same memory assembled from D&N.

Documentation: Instructions for installing jumpers, memory addresses, chip types, jumper locations, and functions are printed on the circuit board.

Reviewer: Earl Morris

Product Name: **Cer-Comp Color Computer Editor**
Equip. req'd: TRS-80C Color Computer
with 16K memory
Price: \$19.95
Manufacturer: Cer-Comp
5566 Ricochet Ave.
Las Vegas, Nevada

Description: A screen editor based on line numbers; resides in R/W memory, distributed on cassette tape using the Color Computer format. The editor has 21 commands that modify text produced in a BASIC-like format. Two edit modes allow spaces or characters to be inserted or deleted from existing lines, and allow forward and reverse scrolling through existing text. Cursor control is either single space per keystroke (forward or back) or single keystroke to reach either end of a line. Block move and copy, search and replace, list to screen or printer with or without line numbers, load and save tapes, append a second tape to existing text, and some special commands for

BASIC files are available. In addition, line numbers can be removed from a file to save space, or added to files from other editors to allow editing.

Pluses: Low price, good versatility, easy to learn, does not require Extended BASIC. Works with machine-language monitors.

Minuses: Instructions and documentation lacking, no listing supplied. Although cursor control is adequate, a repeat key function for continuous cursor scroll would be advantageous.

Skill level required: Normal typing skills, ability to visualize final page format.

Reviewer: Ralph Tenny

Product Name: **Color Computer Disk System**
Equip. req'd: TRS-80 Color Computer,
16K w/Extended BASIC
Price: \$600
Manufacturer: Tandy Radio Shack
P.O. Box 2625
Fort Worth, TX 76113

Description: A 35-track, double-density disk operating system for the Color Computer. Capacity is 156,672 user-available bytes, and 68 maximum files, on a standard 5¼ inch soft-sectored diskette. The system includes a single drive, a disk controller ROM pak, and a connecting cable that allows two drives at a time on line. A four drive cable is optional. System utilities include BACKUP, COPY, and FORMAT. The operating system requires 2K of RAM and no disk space (except for directory tracks). Files are cataloged with an eight-character file name, and three-letter extension. VERIFY, LSET, RSET, MKNS\$, and CVNS\$ are typical commands available to the system which are used in other DOS systems.

Pluses: Because the operating system is on ROM, it requires very little extra memory from the machine. There is no DOS to learn, as disk commands are an extension of BASIC. As there is no DOS with the COLOR disk system, all disk commands can be executed from BASIC, inside or outside a program. The Microsoft disk BASIC includes the "WRITE" command, which allows easier formatting and creation of serial data files, and random access variable length files. The disk BASIC is simple, and easy to learn.

Minuses: Utilities are lacking in sophistication, compared to TRSDOS. Backups require pre-formatted destination disks, and there are no file protection capabilities (other than the write protect tab). BACKUP also copies all bytes on a disk, whether there is one small file, or a full disk. Auto start is not supported, and there are no DO files to provide a turn-key system. This could be partially offset by running a standard file upon power-up. This file could load any machine-language routines, and finally load the desired program from a MENU. The CHAIN command is not supported, although it is possible to load and run a program from inside another program. Another useful command that is missing is the ON ERROR GOTO statement.

Documentation: The owner's manual is written to the same high standards of the other two Color Computer manuals. Instructions pre-suppose no previous experience with disk systems or programming. The style is very readable, and some fine demonstration file programs are included. Missing is the usual TRS-80 programmers card.

Skill level required: Novice.

Reviewer: John Steiner

MICRO

OSI

TRS-80

COLOR-80

OSI

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LABYRINTH - 8K - This has a display background similar to MINOS as the action takes place in a realistic maze seen from ground level. This is, however, a real time monster hunt as you track down and shoot mobile monsters on foot. Checking out and testing this one was the most fun I've had in years! - \$13.95. OSI

THE AARDVARK JOURNAL

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It does have some limitations. It is memory hungry - 8K is the minimum sized system that can run the Compiler. It also handles only a limited subset of Basic - about 20 keywords including FOR, NEXT, IF THEN, GOSUB, GOTO, RETURN, END, STOP, USR(X), PEEK, POKE, =, *, /, <, >, Variable names A-Z, and Integer Numbers from 0-64K.

TINY COMPILER is written in Basic. It can be modified and augmented by the user. It comes with a 20 page manual.

TINY COMPILER - \$19.95 on tape or disk OSI

SUPERDISK II

This disk contains a new BEXEC* that boots up with a numbered directory and which allows creation, deletion and renaming of files without calling other programs. It also contains a slight modification to BASIC to allow 14 character file names.

The disk contains a disk manager that contains a disk packer, a hex/dec calculator and several other utilities.

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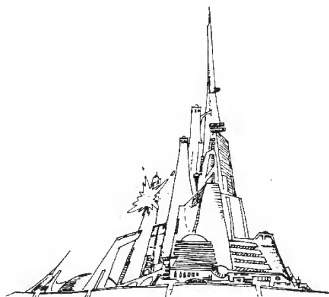
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16K RAM BOARD FOR C1P - This one does not have a parallel port, but it does support 16K of 2114's. Bare Board \$39.95.



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LISZT with Strings

by Leonard H. Anderson, Donald Cohen, Richard F. Searle

LISZT turns your Applesoft program listing into an easy-to-understand structured format. The program is designed to be flexible and works with a variety of printers.

LISZT

requires:

Apple II with Applesoft
Disk Drive
Printer

Can you understand a program you wrote six months ago? Do you remember some of those special tricks imbedded in a concatenated line of code? The "LISZT" (Logical Interpreter Statement Zeugmatic Tabulator) can help you understand BASIC source code listings by structuring printouts in a clear, orderly form with a minimum of extra characters. Written for the Apple II Plus, it can be modified for other BASIC dialects.

Credit is due Mark Capella for the first listing program.¹ Since then, two others have been published.^{2,3} Not completely satisfied, we decided to start fresh with the following rules:

1. Print results so they are easy to read.
2. Make the program adaptable to various printers.
3. Gather statements in strings for flexibility.
4. Separate REMs from printed code.
5. Omit the concatenation colon and "LET."
6. Split over-long print lines at a logical character.
7. Indent FOR-NEXT loops globally.
8. Indent IF-THEN statements locally.
9. Minimize disk operations.

The main program, LISZTER, was written in linear form to accommodate different printers and to allow easy deletion or addition of special features. This article is both a program description and a partial history of program development.

Applesoft Source Code Structure

Source code structure rules the program. One line of Applesoft BASIC is shown in figure 1. Each line contains five overhead bytes: two for a pointer to the next line, two more for the number, and an end-of-line null (binary zero) byte. The last line number source code ends in three null bytes to indicate end-of-program.

All variable names, strings, and punctuation not a function are expressed as 7-bit ASCII with most-significant-bit (MSB) set false or zero. All function words (IF, NEXT, REM, etc.) are stored as one-byte "tokens" with MSB set true or high. There are 107 Applesoft tokens.⁴

Starting the Program Organization

Figure 2 is the initial flow chart. Each program byte is examined, beginning with decimal memory location 2049. ("Standard" ROM Applesoft code begins here. It can be changed and

will vary for other BASICs.) String variables hold the line number in N\$, statement text in a "gather" string, G\$, and the "combination" printout string, C\$.

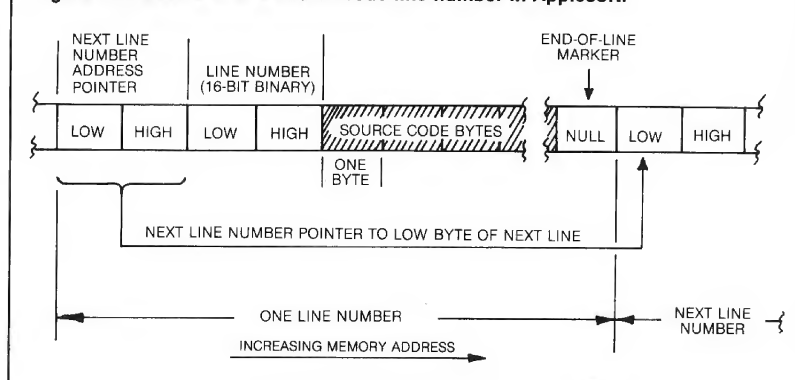
A remarks flag is set if a REM token is encountered. The first decision separates remarks by blank print lines but groups successive remarks without blank lines. Remarks are highlighted without appearing to be part of the main coding.

ASCII characters and token bytes are parsed next with tokens reconverted to the original function word. This section and the print line formatting section receive the most attention. A prime example is separating concatenated statements and allowing indication of over-long text lines.

Holding Two BASIC Programs in Memory

Applesoft reserves two bytes in page zero (first 256 bytes) for the starting address. Start location is *normally* decimal 2049 for ROM BASIC, stored in locations 103 (low byte) and 104 (high byte). End-of-program in memory is in locations 175 (low) and 176 (high). Either can be changed from the keyboard or program in memory.

Figure 1: Structure of one source-code line number in Applesoft.



Apple's DOS allows the simulation of keyboard commands with an EXEC Text File. An EXEC file loads statements into the keyboard buffer. Each statement is then executed as if it were a keyboard command.

The program to be listed is loaded first. The EXEC file is called next by typing "EXEC LISZT." LISZT then changes normal program start address to the end of program plus two, loads and runs the LISZTER working program. Loading LISZTER will automatically set the new end-of-program address.

Although two programs are now in memory, Applesoft will only execute LISZTER as indicated by the starting address changed by EXEC file LISZT. Original start and end addresses are held in page zero scratchpad locations; LISZTER resets start and end from these scratch locations on completion of printout.

EXEC file LISZT is generated by the short program in listing 1. MAKE LISZT may be deleted after generating LISZT. LISZT EXECution commands are those indicated within quotes in MAKE LISZT line numbers 225 through 265.

LISZTER start location is set slightly higher than normally expected. This and the extra nulls will insure that the listed program can be RUN normally after LISZTER resets start and end addresses on printout completion. Normal source code ending must be three successive null bytes.

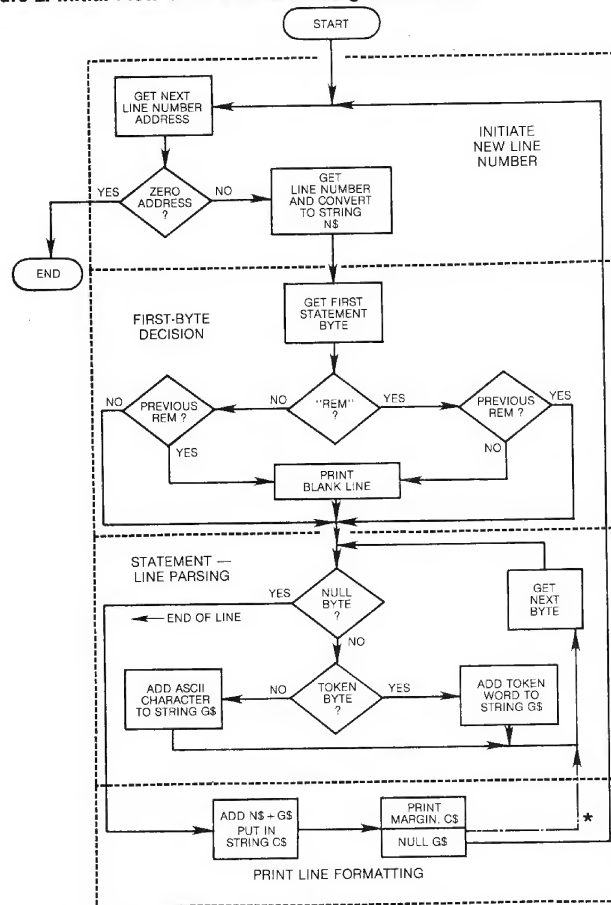
Setting Up LISZTER

LISZTER begins execution at line number 82 by initializing the variables. Initializing will speed up execution, especially with string variables in Applesoft. Token array T\$ contains the 107 function words expressed as literal strings in the DATA statements. Direct expression as strings allows spaces to be added for clarity in gathering and converting the tokens.

The REM token word was changed to an asterisk. It is left as an isolated DATA declaration for those desiring another symbol or word. LET appears as a null string in line 88 to permit completion of the array; token parsing will skip over a LET.

Screen prompts in lines 94 to 100 are optional. Printed page length is normally 60 lines per page including the header. Indent spacing is normally four column spaces, fitting the REM asterisk with three following blanks.

Figure 2: Initial Flow Chart and Sectioning of LISZTER



* Asterisk indicates possible path for next print line of same line number.

Listing 1: MAKE LISZT "EXEC" file generator printed with the LISZTER program in listing 2.

```

MAKE LISZT
LEONARD H. ANDERSON
PRINTOUT ON 20 AUGUST 1981
Page 1

200 * "MAKE LISZT" GENERATOR FOR "LISZT" EXEC FILE
205 * LEONARD H. ANDERSON 7/5/81
210 D$ = Chr$(4)
    C$ = Chr$(13)+D$
215 Print C$ "OPEN LISZT"
220 Print C$ "WRITE LISZT"
225 Print "POKE208,PEEK(103)"
    Print "POKE209,PEEK(104)"
    Print "POKE210,PEEK(175)"
    Print "POKE211,PEEK(176)"
230 Print "POKE104,PEEK(211)"
235 Print "IF PEEK(210)<254 THEN POKE103,(PEEK(210)+1)"
240 Print "IF PEEK(210)>253 THEN
    POKE103,(PEEK(210)-254);POKE104,(PEEK(211)+1)"
245 Print "POKE(PEEK(210)+PEEK(211)*256-2),0"
250 Print "POKE(PEEK(210)+PEEK(211)*256-1),0"
255 Print "POKE(PEEK(210)+PEEK(211)*256),0"
260 Print "POKE(PEEK(210)+PEEK(211)*256+1),0"
265 Print "POKE(PEEK(210)+PEEK(211)*256+2),0"
270 Print "RUN LISZTER"
275 Print D$ "CLOSE"
280 End
  
```

End of Listing

Program Length = 642 Bytes, Total of 17 Line Numbers
19 Total Non-Rem Statements, 2 Total Remarks

Line 104 assumes the printer interface located in peripheral slot 1. The "Poke 33,30" sets screen window width to 30 columns, necessary only for certain Apple I/O interfaces. Line 106 is the main printer control statement.

Subroutines

"GET BYTE" simply advances program byte pointer P and fetches a decimal value of the byte in B. "BLANK LINE PRINT" is used mainly in REM separation. String S\$ is a single blank space and required by Centronics 737 printers; most other printers will accept a single PRINT without a variable.

"TEST PAGE" (lines 6 through 14) does several things: line count (LC) advances and test, header printing and a "continued" indicator print on the current page if another page is to be printed. Since concatenated statements are separated, some may be printed on the following page. Lines 13 and 14 place brackets around the line number and print that on the following page for clarity.

Upper and Lower Case

The mixture of upper and lower case characters is due primarily to the TS array DATA declarations. We decided that program statements would appear better with the familiar function words in a mixture, non-token statements in normal upper-case only. The choice is up to the user.

Since none of us has direct lower-case control, an available utility program was used to "zap" the desired characters directly on the disk. You should do this on a copy file in disk; strange results occur if a token is accidentally changed!

First-Byte Decision

In the section occupying lines 29 through 33 on listing 2 remarks are separated and grouped. A single, first-byte colon in AppleSoft is equivalent to a REM; first-byte colons are changed to REMs since the asterisk-equivalent voids the original source code separation intent.

Statement Line Parsing

Line 34 begins a number of decisions. A null program byte indicates the print line formatting routine at line

(continued)

```

Listing 2
LISTER "UNIVERSAL" VERSION
LEONARD H. ANDERSON
24 JULY 1981
Page 1

0 Goto B2
1 * "GET BYTE" SUBROUTINE
2 P = P+1
3 B = Peek(P)
4 Return
5 * "BLANK LINE PRINT" SUBROUTINE
6 D = 0
7 GOSUB 6
8 Print B$
9 Return
10 * "TEST PAGE" SUBROUTINE. NOTE: SINGLE CHARACTER SET
    PRINTERS SHOULD DELETE "GOSUB 11" & "GOSUB 12"
    THROUGHOUT, LINES 110 THRU 113.
11 LC = LC+1
12 If LC = <LP Then
13 Return
14 * NOT A NEW PAGE
15 GOSUB 111
16 LC = 6
17 PC = PC+1
18 Print B$
19 Print B$; " (continued)"
20 * A FORM-FEED TO GET TOP OF NEXT PAGE AFTER "CONTINUED"
    NOTICE. NOTE: PRINTERS WITH F-F COMMAND CAN USE "PRINT
    CHR$(12)" IN PLACE OF FOR-NEXT LOOP; THE SINGLE-SPACE
    "PRINT S" (THROUGHOUT) IS REQUIRED BY CENTRONICS 737.
21 For K = LP To 63
22 Print B$
23 If Not D Then
24 Return
25 * PUT LINE NUMBER IN BRACKETS AS A STATEMENT
    IDENTIFICATION ON NEXT PAGE
26 K = Len(N$)
27 N$ = Str$(Val(N$))
28 * IS NOW WITHOUT SPACES; BRACKET N$ AND ATTACH TO
    STATEMENT CHARACTERS
29 C$ = Right$(Left$(LB$, (6-K))+Chr$(91)+N$+Chr$(93)+B$, 8)+
    Right$(C$, Len(C$)-8)
30 K = Free(0)
31 Return
32 * GET THE TWO-BYTE POINTER TO NEXT LINE NUMBER; NULL
    INDICATES END.
33 GOSUB 2
34 D = B
35 D = 256+B+D
36 If D > 0 Goto 27
37 * END OF PROGRAM. PRINT NOTICE
38 GOSUB 111
39 GOSUB 4
40 GOSUB 4
41 GOSUB 6
42 Print B$; "End of Listing"
(continued)

```

54. A decimal value between 1 and 127 is an ASCII character byte; any value above 127 is a token.

The double quote test at line 36 allows colons *within* quotes or remarks. Any other colons are treated as delimiter characters and tested at line 37. A delimiter forces a new print line but not a new line number as in the case of a null value byte.

Control characters are converted to upper case equivalents. Besides making control characters visible, conversion allows a printer to continue without suddenly switching to a new mode! We enclosed control characters in vertical bars because that print character has little use in normal printing.

Token byte values are changed to allow you to gather them from the TS array. A token value out of normal range is made into a distinctive word at line 40. A test-true here would indicate an error.

The REM flag set at line 43 is primarily for concatenated remarks. The remarks counter is optional and used only for end-of-listing statistics. REM spacing variable RS is set to one for indenting remarks. While remarks are highlighted, we also wanted their appearance out of the normal program flow.

The FOR flag sets up the start of global FOR-NEXT indenting. The FOR spacing counter is advanced in print line formatting to allow completion of the entire FOR statement. The NEXT test at line 48 removes one FOR indent space. This space is held at zero in case an intermediate (but legal) NEXT is used with the loop.

Conditional tests add an indent space on completion of a THEN. Anything following a THEN, even if only a line number, is considered a separate statement. An IF-GOTO is considered a single statement. The choice was arbitrary to reduce total code.

A LET token is ignored by choice. Omitting line 47 allows you to print a LET.

DATA flag (DF) is used solely in print formatting. When set, it allows splitting an over-long print line only on commas. This is useful when DATA declarations contain strings with spaces as in LISZTER itself.

Listing 2 (Continued)

```

19      * OPTIONAL STATISTICS

20      GOSUB 4
      GOSUB 4
      GOSUB 6
      PRINT M$;"Program Length = _
            ";(PEEK(211)-PEEK(209))*256+PEEK(210)-PEEK(208);" Bytes, _
            Total of ";TN;" Line Numbers"

21      GOSUB 4
      GOSUB 6
      PRINT M$;(TS-TR);" Total Non-Rem Statements, ";TR;" Total_
            Remarks"
      GOSUB 4
      GOSUB 6
      PRINT M$;"END"

22      * TURN OFF PRINTER, DISPLAY END PROMPT ON SCREEN

23      PR# 0
      POKE 33,40
      HOME
      VTab 12
      HTab 11
      Inverse
      PRINT " END OF LISTING "
      Normal

24      * RESET PAGE 0 POINTERS FOR THE LISTED PROGRAM

25      POKE 105,PEEK(210)
      POKE 106,PEEK(211)
      POKE 107,PEEK(210)
      POKE 108,PEEK(211)
      POKE 109,PEEK(210)
      POKE 110,PEEK(211)
      POKE 111,PEEK(115)
      POKE 112,PEEK(116)
      POKE 103,PEEK(208)
      POKE 104,PEEK(209)
      POKE 175,PEEK(210)
      POKE 176,PEEK(211)
      END

26      * MAKE THE LINE NUMBER STRING

27      TN = TN+1
      GOSUB 2
      D = B
      GOSUB 2
      K = B*256+D
      D = LEN(STR$(K))
      N$ = RIGHT$(LEFT$(LB$(7-D))+STR$(K)+""),B)

28      * BEGIN LINE PARSING WITH FIRST-BYTE DECISION

29      TS = TS+1
      D = 0
      GOSUB 2
      IF B = 58 THEN
        B = 178
        * CONVERT "SIMPLE REM" (A ":" FIRST-BYTE) TO ORDINARY
          "REM"

30      IF B = 178 AND NOT RF THEN
        GOSUB 4
        GOTO 34
        * "REM" FLAGS ARE SET AFTER SEPARATION OF TOKENS;
          REM-GROUPS SEPARATED BY BLANK PRINT LINES.

31      IF B = 178 AND RF GOTO 34
        * BYPASS RF RESET

32      IF RF THEN
        RF = 0
        GOSUB 4

33      * RE-ENTRY POINT FOR NEXT BYTE IN STATEMENT DECISION FLOW

34      IF B = 0 GOTO 54
        * FORCE A NEW LINE ON THE END-OF-LINE NULL MARKER

35      IF B>127 THEN
        B = B-127
        GOTO 41
        * BYTE IS A TOKEN; REMAINDER ARE CHARACTERS
  
```

(continued)

Listing (Continued)

```

36 If B = 34 Then
    QF = -QF
    * TOGGLE QUOTE FLAG FOR COLON-PRINT TEST IN NEXT LINE

37 If B = 58 And Not RF And QF<1 Then
    TS = TS+1
    Goto 54
    * OMIT THE CONCATENATION "s" AND FORCE A NEW LINE, ELSE
    PRINT THE COLON AS A CHARACTER

38 If B<32 Then
    B = B+64
    G$ = G$+Chr$(124)+Chr$(B)
    B = 124
    * PRINT CONTROL CHARACTERS AS UPPER-CASE BETWEEN
    VERTICAL BARS; INDICATOR OF CONTROL CHARACTER
    OPTIONAL.

39 G$ = G$+Chr$(B)
    Gosub 2
    Goto 34

40 * INDICATE UNUSED TOKENS AND CONTINUE

41 If B>107 Then
    G$ = G$+" ?! "
    Gosub 2
    Goto 34

42 * ACCEPTABLE TOKENS...

43 If B = 51 Then
    TR = TR+1
    RF = 1
    RS = 1
    * SET BOTH FLAGS AND TOTAL-COUNT ON "REM"

44 If B = 2 Then
    FF = 1
    * A "FOR" IS STARTED

45 If B = 69 Then
    CF = 1
    G$ = G$+T$(B)
    Goto 54
    * FORCE A NEW LINE AFTER PRINTING A "THEN"

46 If B = 4 Then
    DF = 1
    * "DATA" STATEMENT BEGUN; WILL AFFECT INDENTING LATER

47 If B = 43 Then
    Gosub 2
    Goto 34
    * IGNORE A "LET" (IT IS A NULL STRING IN DATA STATEMENT
    LINE #88)

48 If B = 3 Then
    FS = FS-1
    If FS<0 Then
        FS = 0
    * "NEXT" TOKEN REMOVES A "FOR" LOOP INDENT

49 G$ = G$+T$(B)
    Gosub 2
    Goto 34

50 * ADD EXTRA INDENT FOR EACH SPLIT LINE, LIMITING FOR
    LINE-UP OF "REM" AND "DATA" PRINT-OUTS

51 SF = 0
    RS = RS+1
    If RS>2 Then
        RS = 2

52 If DF And RS>1 Then
    RS = 1

53 * GET TOTAL INDENT SPACES FOR PRINT LINE PLUS LOW-LIMIT FOR
    SPLIT-POINT ("E")

54 K = IM$(FS+CS+RS)
    E = K+13
    If K>0 Then
        G$ = Left$(BB$,K)+G$

```

(continued)

Print Line Formatting

The next part of the program sets up indent spaces and splits over-long print lines on a selected character. Splitting is done on ASCII characters since gather string G\$ contains only ASCII values on entrance at line 54.

FOR, REM, and IF spacing counters are added at line 54, multiplied by IM (default value of four), and inserted ahead of G\$. Temporary variable D is an indicator to insert the line number on the first statement. G\$ is set into C\$, then tested for length at line 59. If the C\$ string length is too long, it is split with the right side remainder replacing the former contents of G\$.

Splitting has two priorities. The first priority split occurs at the right-most available space, if it is not a DATA statement. The second priority is an arithmetic operator character (ASCII, not token) or comma; DATA statements split only on commas. While the second priority choice seems arbitrary, it is convenient in terms of ASCII values.

Splitting character search is right to left, beginning with the last available print line column determined by LL. Left limit is determined by temporary variable E (line 54). The original program had an undesired zero left limit; a few print lines were endless blanks!

Another undesired condition occurred with spaces in long strings or PRINTs going beyond the right limit. There was no way to determine if a space existed in the printout. This is solved by lines 74 and 75 adding an underline at the right-most space of the first line, or left-most space of the next line.

Final Print and Cleanup

Every new line calls the TEST PAGE subroutine. This determines if a new page is called for and, if so, prints the "continued" reminder at the bottom, form-feeds, then prints a header on the next page.

Deciding on a one-statement-per-line format gave us the possibility of one or more unnumbered statements on the next page. Holding the readability rule, we decided on placing the next-page line number in brackets (seldom used in Applesoft) while holding the number print justification. Lines 13 and 14 take care of this. An early version used two colons between the

number and statement but conflicted with Backus-Naur notation.

Uncompleted split lines jump to line 51 for extra indents. A remark allows one extra indent count to line up the remark second line with first line text. The REM symbol used here takes four columns or one default indent space. The DATA declaration single indent (line 52) seemed to be most readable.

Separate flag and counter variables on FOR and IF statements allow for concatenation in one line number of source code and the global or local indenting in printout. Local indenting of conditionals is reset on a new line number but global indenting of FOR loops is decremented only on a NEXT token at line 45.

A new source code line number is begun only when the program byte contains the end-of-line null.

Ending it All

Applesoft indicates the end of a listing by three successive nulls. This would appear as a zero line number — a second zero line number, since LISZTER begins with line number zero. This second zero line number falls through the IF in line 16 to begin optional statistical printouts at lines 18, 20, and 21.

Line 23 disables all Apple peripherals by "PR#0", resets screen width to normal by "POKE 33,40", and indicates a finish on the screen. The print command at line 106 allowed the screen to be active at all times even though lower case characters appear as nonsense on a standard Apple.

The POKEs in line 25 reset the start and end pointers to their original values prior to the EXEC file command. Variable and array space pointers are also reset permitting the user to RUN the program after LISZTing.

Optional Starting Prompts

The "RUN 23" notice in line 94 should remain until the user is very familiar with LISZT. It is the only way to restore start and end pointers after a RESET. Address locations in line 95 are optional, useful only with very long programs.

Page length, left margin, and indent spacing are useful only if different paper is used. If available, different vertical printer spacing could be added to

Listing 2 (Continued)

```

55      * ADD LINE NUMBER OR EQUIVALENT-SPACE BLANK
56  If Not D Then
    C$ = N$+B$
57  If D Then
    C$ = LB$+B$
58      * TEST FOR LONG LINE, SPLIT IF NECESSARY
59  K = Len(C$)-LL
    If K<1 Goto 73
    * NOT A SPLIT LINE
60  B$ = Right$(C$,K)
    C$ = Left$(C$,LL)
    SF = 1
    If DF Goto 65
61      * START SPLIT WITH A SPACE FIRST IF NOT "DATA"
62  D = LL
63  If Mid$(C$,D,1) = S$ Goto 71
64  D = D-1
    If D>E Goto 63
65  D = LL
    * SPLIT NEXT AT ARITHMETIC OPERATOR OR COMMA
66  K = Asc(Mid$(C$,D,1))
    If K<42 Or K>47 Goto 69
67  If DF And K = 44 Goto 71
    * "DATA" STATEMENTS SPLIT ONLY ON COMMAS
68  If Not DF And K<>46 Goto 71
    * OTHER STATEMENTS SPLIT BY ALL BUT PERIOD
69  D = D-1
    If D>E Goto 66
70  Goto 73
    * FALL-THROUGH INDICATES END-OF-PRINT-LINE SPLIT
71  K = LL-D
    If K>0 Then
        B$ = Right$(C$,K)+B$
        C$ = Left$(C$,D)
72      * TEST PAGE LINE-COUNT, INSERT SPACES AS ALLOWED, THEN
        PRINT AT LINE #76. NOTE: SINGLE CHARACTER SET PRINTERS
        SHOULD USE ONLY "PRINT M$,C$" BEFORE "K = FRE(0)" IN LINE
        #76.
73  Gosub 6
    K = Len(C$)
    If SF = 0 Or K<2 Or RF Then
        76
74  If Mid$(C$,K,1) = S$ Then
    C$ = Left$(C$, (K-1))+Chr$(95)
    * PUT A TRAILING UNDERLINE IN PLACE OF THE LAST SPACE
    AS A MARKER FOR THE LEFT-HAND STRING
75  If Len(B$)>2 And Left$(B$,1) = S$ Then
    B$ = Chr$(95)+Right$(B$, (Len(B$)-1))
    * PUT A LEADING UNDERLINE IN PLACE OF THE FIRST SPACE
    OF RIGHT-HAND STRING AS A MARKER
76  Gosub 111
    K = Len(C$)
    Print M$,Left$(C$,B$)
    Gosub 112
    Print Right$(C$, (K-B$))
    K = FRE(0)
    If SF Then
        D = 1
        Goto 51
    * PRINT REST OF A SPLIT LINE
77  RF = -1
    RS = 0
    DF = 0
    If FF Then
        FS = FS+1
        FF = 0
78  D = 0
    If CF Then
        CS = CS+1
        CF = 0

```

(continued)

the page length prompt at line 98. A variable left margin requires the BB\$ string to be slightly longer than one-half print line width.

We recommend that you retain the inverse video reminder at line 102. Concentration on program development makes us forget the right buttons to push at crucial moments!

Final Thoughts

A "REM-less" version of LISZTER is about 3.9K long and will run in 5.5K of free memory. Disk operations are not required after the initial EXEC LISZT command.

Hesitation in execution occurs only in parsing long character lines. LISZTER's line 76 takes about 20 seconds to gather, split, and begin printing. The 256-byte string maximum has not yet been reached, including one LISZTING over 30 print pages.

Lack of concatenation character does not seem to hamper reading. Those familiar with the interpreter syntax will know it is always there. Statement separation is easier to understand and is improved further with indenting.

Thanks are due to Cliff Bruhn, Dennis Kaloi, Sterling Tate, Wes Ten, and Bob Keene of Candid Computers for their trial runs, comments, and suggestions.

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5. *Apple II Disk Operating System Reference Manual*, Apple Computer Incorporated.
6. "The Inspector," Omega Micro-ware, Inc., (one of several "zappers" available).

Listing 2 (Continued)

```

79 SF = 0
   B$ = ""
   If B = 0 Then
       CS = 0
       Goto 16
       * GET ANOTHER PRINT LINE IF NOT E-O-L NULL, ELSE FALL
       THROUGH AND GET ANOTHER LINE NUMBER
80 Gosub 2
   D = 1
   Goto 34
81 * INITIALIZATION OF VARIABLES
82 Dim T$(107), H$(4)
83 * INITIAL VARIABLE SETTING HAS AN 80-CHARACTER WIDE PRINT
   LINE AND 60-LINE PAGE LENGTH (INCLUDING HEADER, EXCLUDING
   'CONTINUED' INDICATOR); CHANGE LL AND LP AS DESIRED FOR
   OTHER FORMAT SIZE.
84 * THE "P=2048" IN LINE #85 ASSUMES A NORMAL APPLESOFT ROM
   START AT DECIMAL ADDRESS 2049. CHANGE FOR APPLESOFT IN
   RAM.
85 P = 2048
   B = 0
   RS = 0
   CS = 0
   FS = 0
   RF = 0
   CF = 0
   FF = 0
   DF = 0
   SF = 0
   GF = -1
   LL = 80
   LP = 60
   IM = 4
   E = 0
   TN = 0
   TS = 0
   TR = 0
   S$ = " "
86 C$ = ""
   N$ = ""
   G$ = ""
   M$ = ""
   H$(0) = ""
   LB$ = " "
   BB$ = " "
87 Data "End", "For ", "Next ", "Data ", "Input ", "Del ", "Dim ", "Read ",
   "Gr", "Text", "Pr#", "In#", "Call ", "Plot ", "HLin ", "VLin ",
   "HGr2", "HBr", "HColor = ", "HPlot ", "Draw ", "XDraw ", "HTab ",
   "Home", "Rot = "
88 Data "Scale = ", "ShLoad", "Trace", "NoTrace", "Normal", "Inverse",
   "Flash", "Color = ", "Pop", "VTab ", "Hmem : ", "Lmem : ",
   "OnErr ", "Resume", "Recall ", "Store ", "Speed = ", " ", "Goto ",
   "Run", "If ", "Restore", "& ", "Gosub ", "Return"
89 Data " "
   * ^ CHANGE "REM" TOKEN WORD INDICATOR AS DESIRED
90 Data "Stop", "On ", "Wait ", "Load ", "Save ", "Def ", "Poke ", "Print ",
   "Cont", "List ", "Clear", "Get ", "New", "Tab(", " ", "To ", "Fn ",
   "Spc(", " ", "Then ", " ", "At ", "Not ", "Step ", "+", "-", "*",
91 Data "/", "^", "And ", "Or ", ">", "=", "<", "Sgn", "Int", "Abs", "Usr",
   "Fre", "Scrn(", "Pdl", "Pos", "Sqr", "Rnd", "Log", "Exp", "Cos", "Sin",
   "Tan", "ArcTan", "Peek", "Len", "Str$", "Val", "Asc", "Chr$", "Left$",
   "Right$", "Mid$"
92 For K = 1 To 107
   Read T$(K)
Next
93 * SCREEN PROMPTS AND ALTERNATE LISTING CONSTANTS
94 Home
   VTab 3
   Flash
   Print " RUN 23 ";
   Normal
   Print " RESTORES ORIGINAL AFTER RESET"
   * "RUN 23" RESTORES POINTERS FOR PROGRAM START AND END TO
   ORIGINAL VALUES AND RESETS SCREEN

```

(continued)

Listing 2 (Continued)

```

95 Print
Print "START OF PROGRAM LISTED: "; Peek(209)*256+Peek(208)
Print " END OF PROGRAM LISTED: "; Peek(211)*256+Peek(210)
Print " END OF 'LISZTER': "; Peek(176)*256+Peek(175)

96 * ABOVE IS OPTIONAL, CHECKS TO SEE IF THE 'LISZT' EXEC-FILE
IS OPERATING PROPERLY

97 Print
Input "PROGRAM NAME: "; H$(1)
Input " PROGRAMMER: "; H$(2)
Input " DATE: "; H$(3)
Print
98 Print
Print "PAGE LENGTH IS 60 LINES, WANT OTHER?"
Get H$(0)
If H$(0) = "Y" Then
Input " PAGE LENGTH: "; LP
If LP>62 Goto 98
* LIMIT TO 11" LENGTH AND HEADER START-POSITION; CAN
CHANGE WITH SMALLER-SPACING PRINTERS.

99 Print
Print "NO LEFT MARGIN, WANT ONE ?"
Get H$(0)
If H$(0) = "Y" Then
Input " MARGIN SPACES: "; K
If K>0 And K<49 Then
M$ = Left$(BB$,K)
LL = LL-K
* MARGIN & LINE-LENGTH UNTOUCHED ON WRONG INPUT,
REMAINS AT DEFAULT VALUE

100 Print
Print "INDENT SPACING = 4, WANT OTHER ?"
Get H$(0)
If H$(0) = "Y" Then
Input " SPACING: "; IM
If IM<0 Or IM>12 Goto 100

101 * REMINDER FOR PRINTER SET-UP
102 Home
Inverse
Print " SET PAPER TO TOP OF FORM "
Print " THEN "
Print " TURN ON PRINTER "
Normal
Print
Get H$(0)

103 * SET SCREEN WIDTH, TURN ON PROPER PORT

104 Home
Poke 33,30
Pr# 1

105 * SET-UP FOR EPSON MX-80 PRINTER WITH ORANGE MICRO
'GRAFPLER' OR CENTRONICS-COMPATIBLE PARALLEL INTERFACE
CARD. CCS CARD MUST ADD 'CHR$(9)"K"' TO REMOVE EXTRA
LINE FEED.

106 Print Chr$(9)"82N"Chr$(9)"I"

107 * RESERVED LINE FOR OPTIONAL PRINTER CONTROL
108 * CHR$(9) = "CONTROL-I"

109 LC = 6
PC = 1
Gosub 11
Goto 16

110 * MX-80 ITALICS/STANDARD CHARACTER SET SWITCHING
SUBROUTINES (APPLIES ONLY TO "GRAFTRAX"-AUGMENTED
PRINTERS)

111 Print Chr$(27)"5";
Return
* ESC-5 IS STANDARD SET

112 Gosub 111
If RF Then
Print Chr$(27)"4";
* ESC-4 IS ITALICS SET USED FOR "REM"S

113 Return

```

(continued)

Problems You May Encounter with LISZT with Strings

1. A colon ending a line causes a stop and 'error at line 76' display. The best solution is to use a line editor program or keyboard to correct the program line to remove the extraneous byte. Usually appears to be a 'forgotten' removal during program editing.
2. A double colon starting a line causes LISZTER to think the first colon is a REM, but the second colon causes reversion to gathering tokens and characters in the usual manner. Using an italics set on the printer will make this line look like a REM splat, but has both upper and lower case contents. Best solution is to edit out the extra colons.
3. A statement ending nested FOR loops such as "NEXT J,K,L" executes in Apple-soft as if they were three separate NEXT statements. Since LISZTER will only recognize one NEXT token, all following lines will retain the FOR-NEXT indent(s) for the remainder of printout.

We don't have a simple solution for this — yet. Changing the program to "NEXT J:NEXT K:NEXT L" will add only two bytes and bring the left margin back to normal. The two added bytes are the NEXT tokens; concatenation colons take the place of the commas.

4. On any mid-printout deliberate stop, such as RESET, you must key in RUN 23 to restore the program start and end pointers. Failure to do so may attach LISZTER to the program being listed.

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Listing 2 (Continued)

```

114 * "LISZTER"
115 * Working Program to
116 * re-format
117 * APPLESOFT Programs for
118 * Printing
119 *
120 * BY
121 * LEONARD H. ANDERSON
122 *
123 * Version 4.1.3, 7/24/81
124 * (lower-case version)
125 * MX-80 & "GRAFTAK"
126 * (ITALICS ON RENS)
127 *
128 * DESCRIPTION OF VARIABLES:
129 *
130 * B PROGRAM BYTE DECIMAL VALUE
131 * BB$ 'BIG BLANK' STRING OF 48 SPACES
132 * CF "IF" FLAG: 1 = "IF" STARTED; 0 = NO "IF"
133 * CS "IF" (CONDITIONAL) INDENT SPACE COUNTER
134 * C$ CHARACTER AND TOKEN STRING TO BE PRINTED
135 * D 'DIRECTION', A TEMPORARY
136 * DF "DATA" FLAG (ALLOWS SPLIT ON COMMA ONLY)
137 * 1 = "DATA" EXISTS ON LINE; 0 = NO "DATA"
138 * E TEMPORARY, PARTLY FOR SPLIT-LINE LIMITS
139 * FF "FOR" FLAG: 1 = "FOR" STARTED; 0 = NO "FOR"
140 * FS "FOR" INDENT SPACING COUNTER
141 * G$ 'GATHER' STRING TO BUILD STATEMENT LINE
142 * H$ HEADER ARRAY FOR PAGE TITLE
143 * IM INDENT SPACE MULTIPLIER
144 * K TEMPORARY
145 * LB$ 'LITTLE BLANK' STRING OF 8 SPACES
146 * LC LINE COUNTER FOR PAGINATION TEST
147 * LL LINE-LENGTH (WIDTH) CONSTANT
148 * LP LINES-PER-PAGE CONSTANT
149 * M$ LEFT MARGIN SPACING STRING
150 * N$ LINE NUMBER STRING
151 * P POINTER TO PROGRAM BYTE (DECIMAL VALUE)
152 * PC PAGE COUNTER FOR HEADER ON EACH PAGE
153 * QF QUOTE FLAG TO ALLOW/DISALLOW COLON PRINTING
154 * -1 = NO QUOTE OR SECOND QUOTE OF PAIR EXISTS
155 * +1 = FIRST QUOTE OF PAIR EXISTS, ALLOW COLONS
156 * RF "REM" FLAG: 1 = "REM" STARTED; 0 = NO "REM"
157 * RS "REM" INDENT SPACING COUNTER
158 * SF SPLIT-LINE FLAG; SET IF PRINT LINE MUST BE SPLIT
159 * S$ SINGLE SPACE STRING
160 * TN TOTAL LINE NUMBER COUNTER
161 * TR TOTAL REMARK-STATEMENT COUNTER
162 * TS TOTAL STATEMENT COUNTER
163 *
164 * AN EXAMPLE OF INDENTS ON NESTED "FOR" LOOPS:
165 For J = 1 To 25
166 For K = J To 26
167 If MT(J,K) = 0 Goto 170
168 For L = J To K
169 If MT(J,K)<>0 Then
170 MT(K,L) = MT(K,L)-(MT(J,K)*MT(J,L))
171 * BEGINS WITH "LET MT(..."
172 Next L
173 Next K
174 Next J
175
176 *
177 * /I/ /B/ /I/
18000 * THE PRECEDING LINE CONTAINED TWO CONTROL-I CHARACTERS
18000 * SEPARATED BY A CONTROL-B (BELL).

```

End of Listing

Program Length = 10061 Bytes, Total of 175 Line Numbers

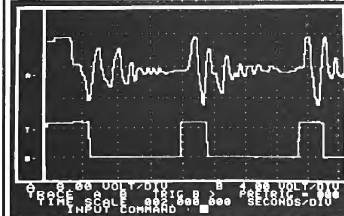
271 Total Non-Rem Statements, 119 Total Remarks

END

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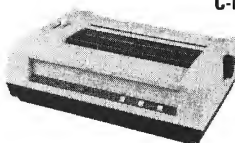
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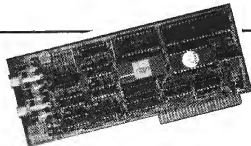
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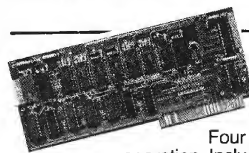
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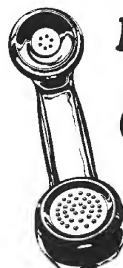
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Apple Graphics for Okidata Microline 80

by Charles F. Taylor, Jr.

Programs are given, in Apple/UCSD Pascal and 6502 assembly language, to dump the Apple high-resolution graphics screen(s) to an Okidata Microline 80 printer. This article should also be of interest to owners of the Epson MX-80 printer because graphics on the two printers are implemented similarly.

These Apple Graphics routines require:

Apple
Okidata Microline 80, 82A,
or 83A
Epson MX-80

Pascal version requires:

Apple Pascal system

When I purchased my Okidata Microline 80 dot matrix impact printer, I was attracted to its relatively low price, the 200,000,000-character print head warranty, and the flexible form handling (friction and pin feed). I really didn't consider its graphics, which were advertised as "TRS-80-compatible."

After I'd had the printer for a while, I decided to take another look at its graphics capabilities. The basic graphical unit for the Microline 80 is the graphics character. Each graphics character may be thought of as a 3-row by 2-column matrix, as depicted in figure 1.

The individual elements of the graphics character are numbered 1-6 as in figure 1. Each element of the character may be "on" (black) or "off" (white), which means that there are 2 to the 6th power, or 64, possible distinct graphics characters. An element that is "on" is represented by what appears (under magnification) to be a 3 by 3 matrix of dots. The total graphics character, then, is a 9-row by

6-column matrix. This is achieved with a 7-pin print head by making two passes for every line which contains a graphics character, advancing the paper slightly between passes.

With the printer set for 16.5 characters per inch on an 8-inch line, the horizontal resolution is 0.030 inches (0.77 millimeters). At eight lines per inch, the vertical resolution is 0.042 inches (1.06 millimeters). In other words, the smallest "dot" that can be printed is an element of a graphics character which is a rectangle 0.030 inches wide by 0.042 inches high.

Each graphics character is sent to the printer as a single byte with the high-order bit (bit 8) set (1). Bit 7 may be either 0 or 1. Bits 1 through 6 are set (1) or clear (0) as the correspondingly numbered element of the graphics character is "on" or "off." (See figure 1 again.)

Software could be written to utilize these graphics characters directly. This would include, as a minimum, routines to set and clear individual elements of graphics characters and to draw straight lines between any two points. Because Applesoft BASIC and Apple/UCSD Pascal each provide these graphics primitives for use with the Apple high-resolution screen, a better approach is to develop a utility program to dump, point by point, the contents of the hi-res screen to the printer. This was the approach I took, first in Pascal, then in 6502 assembly language. (The latter version can be called from BASIC programs.)

The basic unit of Apple hi-res graphics is of course the "pixel" or dot. The hi-res screen is organized as a 192-row by 280-column matrix of individually addressable pixels. The display is bit-mapped; that is, there exists a mapping between each pixel on the screen and a bit somewhere in memory.

There were three principal problems to be resolved in designing the

program: the first problem was how to address the bit representation of each pixel in order to determine whether it is on or off. The second problem was to decide whether to print the screen image horizontally or vertically on the printer. Finally, a means had to be found to map six pixels to each graphics character.

Pascal Solution

The solution in Pascal is presented first because it is simpler. This is because of the existence of the SCREENBIT function, which is provided as part of the TURTLEGRAPHICS unit. SCREENBIT(x,y) is a Boolean function which returns the value TRUE if pixel

Figure 1: Microline 80 Graphics Character

| | |
|---|---|
| 1 | 2 |
| 3 | 4 |
| 5 | 6 |

Figure 2: Model of High Resolution Screen (6 x 6)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | |
| 5 | * | | | | | | 0 |
| 4 | * | * | | | | | 1 |
| 3 | * | | * | | | | 2 |
| 2 | * | | | * | | | 3 |
| 1 | * | | | | * | | 4 |
| 0 | * | | | | | * | 5 |
| | 0 | 1 | 2 | 3 | 4 | 5 | |

(x,y) is on (not black), and FALSE if it is off (black). This makes the first problem cited above almost trivial.

Since only a maximum of 132 characters can be printed on a line (16.5 characters per inch times 8 inches), and each character is two elements wide, the maximum number of pixels which can be presented on a printed line is 264. Because the Apple hi-res screen is 280 pixels wide, two choices are possible: (1) print the screen image vertically on the printer, 192 elements across and 280 down; or, (2) print the screen image horizontally, but print only 264 of the 280 columns. The former choice was made for the Pascal version and the latter for the 6502 assembly language version.

The Pascal program is shown in listing 1. The main program queries the user as to whether to print all or a specified portion of the screen. Procedure SETUP handles the details of turning on the printer and selecting the

proper print size and vertical spacing. Procedure TURNOFF turns the printer off again. The real work is done in the procedure called SCREENDUMP.

How the algorithm works can best be illustrated by example. Assume that the Apple hi-res screen consists of a 6-row by 6-column grid as shown in figure 2, and that an arbitrary pattern has been plotted on it. An "*" is used to indicate which grid elements are "on." In Pascal (as opposed to BASIC) the origin is at the lower left corner of the grid, so the numbers along the left side refer to the row of y-coordinates. The numbers along the right side will not be needed until later.

The Pascal program will reduce this grid to two lines of three graphics characters each. The first line will represent columns (x-coordinates) 0, 1, and 2 of the grid and the second line columns 3, 4, and 5. Remember that the image on the printer will be rotated

Table 1

| Graphics Characters | Screen Grids |
|---------------------|--------------|
| Bit | Position |
| 1 | (0,0) |
| 2 | (0,1) |
| 3 | (1,0) |
| 4 | (1,1) |
| 5 | (2,0) |
| 6 | (2,1) |

90 degrees, so that columns on the screen correspond to rows on the printer and *vice versa*.

The first graphics character of the first line will represent rows (y-coordinates) 0 and 1 of the columns 0, 1, and 2. We may imagine the grid of figure 1 superimposed on the grid of

Listing 1

```
PROGRAM PRINTSCREEN;

(*S***)
(* DUMPS ENTIRE PASCAL SCREEN *)
(* TO OKIDATA MICROLINE 80 *)
USES TURTLEGRAPHICS;

VAR XMIN, XMAX, YMIN, YMAX : INTEGER;

PROCEDURE SCREENDUMP(XMIN, XMAX, YMIN, YMAX : INTEGER);

(* DUMPS PASCAL GRAPHICS TO *)
(* OKIDATA MICROLINE 80 *)

VAR H, I, J, K : INTEGER;
LINE : ARRAY [1..96] OF CHAR;
BIT : ARRAY [1..6] OF 0..1;
OKI : TEXT;

PROCEDURE SETUP;
BEGIN
  (* OPEN PRINTER FILE *)
  REWRITE (OKI, 'PRINTER:');
  (* SET CENTRONICS CARD FOR 132 COLS *)
  WRITELN (OKI, CHR(9), '132N');
  (* SET PRINTER FOR 16.5 CPI & 8 LPI *)
  WRITELN (OKI, CHR(29), CHR(27), '8', CHR(27), 'B');
END; (* SETUP *)

PROCEDURE TURNOFF;

(* RESETS OKIDATA *)

BEGIN
  WRITELN (OKI, CHR(30), CHR(27), '6', CHR(27), 'A');
END; (* TURNOFF *)

FUNCTION GCHAR : CHAR;

(* RETURNS GRAPHICS CHARACTER *)
(* DEFINED BY BIT ARRAY *)

VAR NR : 0..255;
POWER, I : INTEGER;

BEGIN
  POWER := 1;
  NR := 128;
  FOR I := 1 TO 6 DO
    BEGIN
      NR := NR + POWER*BIT[I];
      POWER := 2*POWER;
    END;
```

Listing 1 (Continued)

```
GCHAR := CHR(NR);
END; (* GCHAR *)

BEGIN (* PROCEDURE SCREENDUMP *)
  SETUP;
  FOR K := 1 TO 96 DO
    LINE[K] := CHR(128);
    I := XMIN;
    REPEAT
      J := YMIN;
      K := 1 + YMIN DIV 2;
      REPEAT
        FOR H := 1 TO 6 DO BIT[H] := 0;
        IF SCREENBIT(I, J) THEN BIT[1] := 1;
        IF SCREENBIT(I, J+1) THEN BIT[2] := 1;
        IF SCREENBIT(I+1, J) THEN BIT[3] := 1;
        IF SCREENBIT(I+1, J+1) THEN BIT[4] := 1;
        IF SCREENBIT(I+2, J) THEN BIT[5] := 1;
        IF SCREENBIT(I+2, J+1) THEN BIT[6] := 1;
        LINE[K] := GCHAR;
        K := K + 1;
        J := J + 2;
      UNTIL J+1 > YMAX;
      FOR K := 1 TO 96 DO
        BEGIN
          WRITE (OKI, LINE[K]);
          LINE[K] := CHR(128);
        END;
        WRITELN(OKI);
        I := I + 3;
      UNTIL I+2 > XMAX;
      TURNOFF;
    END; (* SCREENDUMP *)

  BEGIN (* MAIN PROGRAM *)
    REPEAT
      WRITE ('FIRST COLUMN TO PRINT (0..279):');
      READLN(XMIN);
      UNTIL (XMIN) = 0 AND (XMIN <= 279);
      REPEAT
        WRITE ('LAST COLUMN TO PRINT (XMIN..279):');
        READLN(XMAX);
        UNTIL (XMAX) = XMIN AND (XMAX <= 279);
      REPEAT
        WRITE ('FIRST ROW TO PRINT (0..191):');
        READLN(YMIN);
        UNTIL (YMIN) = 0 AND (YMIN <= 191);
      REPEAT
        WRITE ('LAST ROW TO PRINT (YMIN..191):');
        READLN(YMAX);
        UNTIL (YMAX) = YMIN AND (YMAX <= 191);
      SCREENDUMP(XMIN, XMAX, YMIN, YMAX);
    END.
```

figure 2, with figure 1 rotated 90 degrees [counter-clockwise]. Thus bits of the graphics characters correspond to screen grids as shown in table 1. In this case bits 3, 4, 5, and 6 will be 0 and bits 1 and 2 will be 1. Bit 7 will [arbitrarily] be 0, and bit 8 will be 1, as discussed earlier. The resulting graphics character is, therefore, binary 10000011 [\$83 or decimal 131].

The next graphics character of the line will be constructed from grid elements {0,2}, {1,2}, {2,2}, {0,3}, {1,3}, and {2,3}, which correspond to, respectively, bits 1, 3, 5, 2, 4, and 6. In this case bits 1, 2, and 6 will be 1 and bits 3, 4, and 5 will be 0. The resulting graphics character is binary 10100011 [\$A3, or decimal 163]. The third and final graphics character of the line will be binary 10000111, [\$87, or decimal 135].

At this point the program has constructed the first full line of graphics characters. Using the CHR function, the computed decimal values have been converted to their character equivalents and are stored in the array LINE. Now that LINE is full, it is sent to the printer, one character at a time, and is followed by the usual carriage return and line feed [WRITELN].

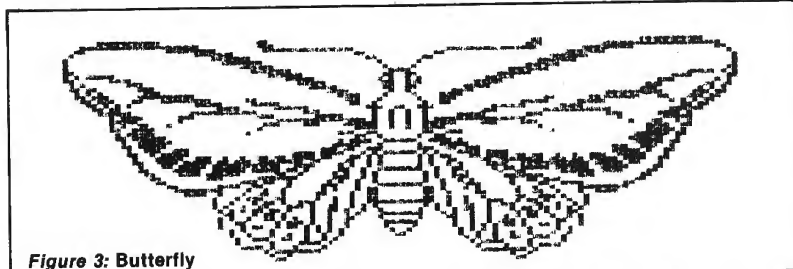


Figure 3: Butterfly

The program then constructs the next line of graphics characters from columns 3, 4, and 5 of the screen grid. These characters will be, in decimal notation, 152, 129, and 128, respectively.

The procedure described above is carried out by the procedure SCREEN-DUMP. The function GCHAR uses simple arithmetic to convert the binary representation of the character to decimal. Then it uses CHR to convert the decimal value to a character. Experienced Pascal programmers may notice that I could have accomplished the binary-to-character conversion directly using a free-union variant record. That technique would have been faster and more efficient, but less clear. Readers who wish to pursue this topic should refer to an article by David

Casseres of Apple Computer Inc., which appeared in the October 1981 issue of *BYTE* magazine.

Figure 3 is an example of output produced by this program. The butterfly image was created on the screen by a demonstration program furnished with the Apple Pascal system and then printed on the Microline 80 by this program.

Assembly Language Solution

The most difficult part of the 6502 assembly language solution was to develop an algorithm to step through memory, addressing of each pixel's bit representation in the proper sequence. (Recall that this was done for us in Pascal by SCREENBIT.) The task is complicated by the fact that, for various reasons, Apple chose to represent the hi-res screen in memory in what appears to be a rather peculiar sequence. The mapping used is documented in the *Apple II Reference Manual* and was the subject of a 1978 article in *MICRO* (7:43) by Andrew H. Eliason. Rather than reiterate the details here, I have chosen to present a short Applesoft BASIC program (listing 2) which prints out the beginning address (in decimal and in hex) of each of the 192 rows of hi-res screen 1. (To get the corresponding values for screen 2, change line 100.) The 280 pixels of each row are represented by seven bits of each of the 40 bytes beginning at the location given. The program prints a screen, then prompts the user to press the space bar before running another screen.

As mentioned above, I decided to represent the screen horizontally on the printer in this version (which considerably simplifies the arithmetic). This means that only 264 columns of the hi-res screen could be printed. The first 264 were arbitrarily selected.

The 6502 assembly language program is shown as listing 3. Instructions for its use are contained in the program's introductory comments. The printer interface I used was the Apple

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SPEED-DS is a routine to modify the statement linkage in an Applesoft program to speed its execution, improvements of 5-20% are common. As a bonus, **SPEED-DS** includes machine language routines to speed string handling and reduce the need for garbage clean-up. Author: Lee Meador.
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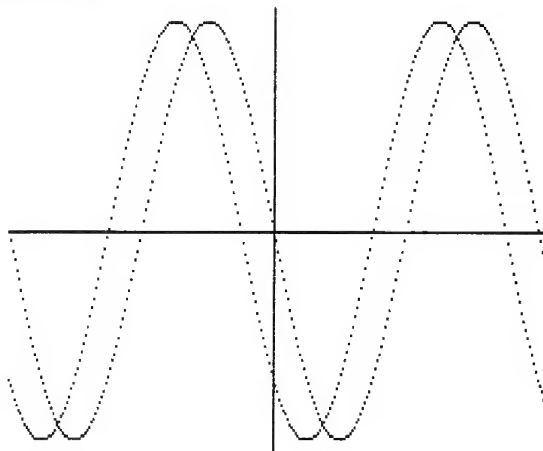
Listing 2

```

10 REM PROGRAM TO DEMONSTRATE
20 REM THE SEQUENCE OF STORAGE
30 REM LOCATIONS USED BY THE
40 REM APPLE HI-RES SCREEN
50 REM
60 REM BY C.F. TAYLOR, JR.
70 REM JULY 24, 1981
80 REM
90 HOME
95 DIGIT$ = "0123456789ABCDEF"
100 B0 = 8192: REM FOR SCREEN 1
110 SLIN = 0: REM SCREEN LINE NR
120 FOR I = 1 TO 3
130 B1 = B0
140 FOR J = 1 TO 8
150 CLIN = B1
160 FOR K = 1 TO 8
170 GOSUB 500: REM CONVERT TO HEX
180 PRINT SLIN, CLIN, HL$
190 SLIN = SLIN + 1
200 CLIN = CLIN + 1024
210 IF SLIN = INT (SLIN / 23) * 23 ( ) 0 THEN GOTO 240
220 PRINT "PRESS (SPACE) TO CONTINUE":
230 GET A$: PRINT
240 NEXT K
250 B1 = B1 + 128
260 NEXT J
270 B0 = B0 + 40
280 NEXT I
290 END
500 X = CLIN: REM SUBROUTINE CONVERT TO HEX
510 HL$ = ""
520 HL$ = MID$ (DIGIT$, X - INT (X / 16) * 16 + 1, 1) + HL$
530 X = INT (X / 16)
540 IF X ( ) 0 THEN GOTO 520
550 HL$ = "$" + HL$
560 RETURN

```

Figure 4: Sine Curves



Centronics Parallel Interface; some modifications will likely be required for use with other interface cards. What is critical is that bit 8 must be controllable (high for graphics, low for text). Some interfaces may not use bit 8 at all, or may force it low. The Epson interface board has bit 8 wired to ground, but a jumper is provided for changing this. If you do modify the setting of this jumper, however, you will have to make some other provision for forcing bit 8 low for text. My recommendation is to replace the jumper

with a single-pole, double-throw switch. This is, in effect, what I have done to my Apple Centronics Interface card.

How the assembly language program works can also be illustrated by example. Refer again to figure 2. This time we will use the row numbers (y-coordinates) along the right edge, recalling that BASIC refers to the upper left corner as (0,0). This time rows 0, 1, and 2 will be used to construct the first line of graphics characters and rows 3, 4, and 5 the second line.

The first graphics character will therefore represent columns 0 and 1 of rows 0, 1, and 2. We may imagine the grid of figure 1 superimposed on the grid of figure 2, but this time without rotation. Thus bits 1-6 of the graphics character will represent, respectively, the screen grid positions (0,0), (1,0), (0,1), (1,1), (0,2), and (1,2). Bits 1, 3, 4, and 5 will be 1 and bits 2 and 6 will be 0. As before, bit 7 will be 0 and bit 8 will be 1. Therefore, the first graphics character is binary 10011101 (\$9D, or decimal 157).

For the second graphics character, bits 1-6 correspond, respectively, to coordinates (2,0), (3,0), (2,1), (3,1), (2,2), and (3,2). Bit 5 is 1 and bits 1, 2, 3, 4, and 6 are 0. This translates to binary 10010000 (\$90, or decimal 144). The third and last graphics character of the first line is binary 10000000 (\$80, or decimal 128). The decimal values of the three graphics characters of the second line are 149, 130, and 164.

The algorithm illustrated in the BASIC program of listing 2 is used to find the beginning of each of three consecutive rows of the screen in memory. The bytes representing the pixels of these lines are then transferred to working buffers. (Only 38 bytes out of 40 are used because only 264 out of 280 columns are plotted.) The subroutines DUMP and DUMPY then extract the appropriate bits from the buffers and rotate them into a page zero location called CHAR. From there each is sent to the printer.

Figure 4 shows a typical plot of two out-of-phase sine curves. More sophisticated plots (3-D, etc.) are of course possible; anything you can put on the screen, you can print! The one limitation is color since the printer only prints black and white!

Execution time for the assembly language version is typically about six minutes. The Pascal version takes about 2.5 times as long to print a full screen.

Although the programs presented here were reasonably involved to write, they are simple to use. Best of all, they transform a fairly unsophisticated graphics capability on an inexpensive printer into a powerful graphics tool, rivaling printers costing several times as much.

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Listing 3

```

0010      ;HI-RES SCREEN DUMP
0020      ;APPLE II PLUS TO
0030      ;OKIDATA MICROLINE 80 VIA
0040      ;APPLE CENTRONICS PARALLEL INTERFACE
0050      ;
0060      ;WRITTEN BY C. F. TAYLOR, JR.
0070      ;24 JULY 1981
0080      ;
0090      ;INSTRUCTIONS:
0100      ;
0110      ; SET HIMEM: 37760 BEFORE LOADING
0120      ; CALL 37888 FOR HI-RES PAGE 1
0130      ; CALL 37904 FOR HI-RES PAGE 2
0140      .BA $5400
0150      .DS
0160      .DE $638      ;LOCATIONS USED
0170      .DE $688      ;PRINTER INTERFACE
0180      .DE $468      ;ROM
0190      .DE $588
0200      .DE $03EA      ;DOS RE-ENTRY POINT
0210      .DE $06      ;PAGE 0 LOCATIONS
0220      .DE $08
0230      .DE $E3
0240      .DE $C102      ;PRINTER DRIVER
0250      ;
0260      ;ENTRY POINT FOR HI-RES PAGE 1
0270      ;
9400- A9 20      0280      PAGE1      LDA #$20      ;INITIALIZE POINTERS
9402- 8D 97 95      0290      STA BASE+1
9405- 8D 99 95      0300      STA SAVBAS+1
9408- A9 40      0310      LDA #$40
940A- 8D 9D 95      0320      STA CURLIM+1
940D- 4C 1D 94      0330      JMP START
0340      ;
0350      ;ENTRY POINT FOR HI-RES PAGE 2
0360      ;
9410- A9 40      0370      PAGE2      LDA #$40      ;INITIALIZE POINTERS
9412- 8D 97 95      0380      STA BASE+1
9415- 8D 99 95      0390      STA SAVBAS+1
9418- A9 60      0400      LDA #$60
941A- 8D 9D 95      0410      STA CURLIM+1
0420      ;
941D- A9 00      0430      START      LDA #$00      ;COMMON POINTER VALUES
941F- 8D 96 95      0440      STA BASE
9422- 8D 98 95      0450      STA SAVBAS
9425- 8D 9B 95      0460      STA SLIN
9428- 8D 9C 95      0470      STA CURLIM
942B- 20 9D 94      0480      JSR SETUP      ;INITIALIZE PRINTER
942E- A9 02      0490      LDA #2      ;INITIALIZE BUFFER LINE NR
9430- 8D 9A 95      0500      STA LINE
0510      ;
9433- AD 96 95      0520      LOOPA      LDA BASE      ;CLIN := BASE
9436- 85 06      0530      STA *CLIN
9438- AD 97 95      0540      LDA BASE+1
943B- 85 07      0550      STA *CLIN+1
0560      ;
943D- 20 CA 94      0570      LOOPB      JSR BUFLIN      ;INCREMENT BUFFER LINE NR
9440- EE 9B 95      0580      INC SLIN      ;AND SCREEN LINE NR
9443- A0 25      0590      LDY #37      ;TRANSFER LINE TO BUFFER
9445- B1 06      0600      B1      LDA (CLIN),Y
9447- 91 08      0610      STA (BUFF),Y
9449- 88      0620      DEY
944A- 10 F9      0630      BPL B1
944C- AD 9A 95      0640      LDA LINE      ;TIME TO DUMP BUFFER?
944F- C9 02      0650      CMP #2
9451- D0 03      0660      BNE CONT
9453- 20 0A 95      0670      JSR DUMP
9456- A5 07      0680      CONT      LDA *CLIN+1

```

Listing 3 (Continued)

```

9458- 18      0690      CLC
9459- 69 04      0700      ADC #$4      ;INCREMENT MEMORY LOCATION
945B- 85 07      0710      STA *CLIN+1
945D- CD 9D 95      0720      CMP CURLIM+1      ;TIME TO ADJUST BASE?
9460- 90 DB      0730      BCC LOOPB      ;NO
9462- AD 9B 95      0740      LDA SLIN      ;SCREEN LINE NR
9465- C9 40      0750      CMP #64      ;READY TO SHIFT?
9467- F0 06      0760      BEQ SC0      ;YES
9469- C9 80      0770      CMP #128
946B- F0 02      0780      BEQ SC0      ;YES
946D- D0 15      0790      BNE SC1      ;NO
946F- AD 96 95      0800      LDA SAVBAS
9472- 18      0810      CLC
9473- 69 28      0820      ADC #$28      ;SHIFT BASE
9475- 8D 98 95      0830      STA SAVBAS
9478- 8D 96 95      0840      STA BASE
947B- AD 99 95      0850      LDA SAVBAS+1
947E- 8D 97 95      0860      STA BASE+1
9481- 4C 33 94      0870      JMP LOOPA
9484- C9 C0      0880      SC1      CMP #192      ;DONE?
9486- F0 14      0890      BEQ EXIT      ;YES
9488- 18      0900      CLC      ;ADJUST BASE
9489- AD 96 95      0910      LDA BASE
948C- 69 80      0920      ADC #$80
948E- 8D 96 95      0930      STA BASE
9491- AD 97 95      0940      LDA BASE+1
9494- 69 00      0950      ADC #0      ;ADD IN CARRY
9496- 8D 97 95      0960      STA BASE+1
9499- 4C 33 94      0970      JMP LOOPA
949C- 60      0980      EXIT      RTS      ;DONE
0990      ;
1000      ;SUBROUTINES FOLLOW
1010      ;
1020      SETUP
949D- A2 C1      1030      LDX #C1      ;FOR SLOT 1
949F- A9 09      1040      LDA #09      ;INITIALIZE DRIVER
94A1- 9D B8 06      1050      STA FLAGS,X      ;VIDEO OFF
94A4- A9 FF      1060      LDA #$FF
94A6- 9D B8 0A      1070      STA PMDTH,X      ;PRINT WIDTH
94A9- 9D 38 06      1080      STA ESCHR,X      ;ESCAPE CHAR
94AC- A9 00      1090      LDA #0
94AE- 9D B8 05      1100      STA MODE,X      ;CLEAR 'AFTER ESC' MODE
94B1- 20 EA 03      1110      JSR DOS      ;REPLACE WITH 3 NOP'S
1120      ;FOR CASSETTE SYSTEM
1140      ;NOW SETUP PRINTER
94B4- A9 1D      1150      LDA #1D      ;SET 16.5 CPI ON PRINTER
94B6- 20 02 C1      1160      JSR DRIVER
94B9- A9 18      1170      LDA #18      ;SET 8 LINES
94BB- 20 02 C1      1180      JSR DRIVER      ;PER INCH
94BE- A9 38      1190      LDA #38      ;VERTICAL SPACING
94C0- 20 02 C1      1200      JSR DRIVER      ;ON PRINTER
94C3- 60      1210      RTS
1220      ;
94C4- EE 9A 95      1230      BUFLIN      INC LINE
94C7- AD 9A 95      1240      LDA LINE
94CA- C9 03      1250      CMP #3
94CC- D0 0E      1260      BNE BL1
94CE- A9 81      1270      LDA #81      ;SET BUFFER LINE 0
94D0- 85 08      1280      STA *BUFF
94D2- A9 93      1290      LDA #93      ;H, LINE0
94D4- 85 09      1300      STA *BUFF+1
94D6- A9 00      1310      LDA #0
94D8- 8D 9A 95      1320      STA LINE
94DB- 60      1330      RTS
94DC- C9 01      1340      BL1      CMP #1      ;SET BUFFER LINE 1
94DE- D0 09      1350      BNE BL2
94E0- A9 A7      1360      LDA #A7      ;L, LINE1
94E2- 85 08      1370      STA *BUFF

```

Listing 3 (Continued)

```

94E4- A9 93 1380 LDA #H,LINE1
94E5- B5 09 1390 STA *BUFF+1
94E6- 60 1400 RTS
94E9- A9 CD 1410 BL2 LDA #L,LINE2 :SET BUFFER LINE 2
94EB- 85 08 1420 STA *BUFF
94ED- A9 93 1430 LDA #H,LINE2
94EF- 85 09 1440 STA *BUFF+1
94F1- 60 1450 RTS
          1460 ;
94F2- AD 98 95 1470 SCRLIN LDA SLIN :CHECK FOR SHIFT OF BASE
94F5- C9 A0 1480 CMP #54
94F7- D0 10 1490 BNE NX1
94F9- C9 80 1500 CMP #128
94FB- D0 0C 1510 BNE NX1
94FD- AD 98 95 1520 LDA SAVBAS
9500- 18 1530 CLC
9501- 69 28 1540 ADC #*28
9503- 8D 98 95 1550 STA SAVBAS
9506- 8D 96 95 1560 STA BASE
9509- 60 1570 NX1 RTS
          1580 ;
950A- A2 00 1590 DUMP LDX #0 :DUMP BUFFERS TO PRINTER
950C- A9 00 1600 DUMP1 LDA #0
950E- 85 E3 1610 STA *CHAR
9510- A0 02 1620 LDY #2
9512- 20 37 95 1630 JSR DUMPY :Y+1 CHARS TO PRINTER
9515- 20 68 95 1640 JSR TRANS :TRANSITION TO NEXT BYTE
9518- E8 1650 INX
9519- A0 02 1660 LDY #2
951B- 20 37 95 1670 JSR DUMPY :REST OF BYTE
951E- E8 1680 INX
951F- E0 24 1690 CPX #36 :DONE?
9521- 30 E9 1700 BMI DUMP1
9523- A0 02 1710 LDY #2 :FINISH COLS 127-132
9525- 20 37 95 1720 JSR DUMPY
9528- 20 68 95 1730 JSR TRANS
952B- E8 1740 INX
952C- A0 01 1750 LDY #1
952E- 20 37 95 1760 JSR DUMPY
9531- A9 00 1770 LDA #*00 :CARRIAGE RETURN
9533- 20 02 C1 1780 JSR DRIVER
9536- 60 1790 RTS
          1800 ;
9537- 7E 81 93 1810 DUMPY ROR LINE0,X :Y+1 BYTES TO PRINTER
953A- 66 E3 1820 ROR *CHAR :BIT 1
953C- 7E 81 93 1830 ROR LINE0,X
953F- 66 E3 1840 ROR *CHAR :BIT 2
9541- 7E A7 93 1850 ROR LINE1,X
9544- 66 E3 1860 ROR *CHAR :BIT 3
9546- 7E A7 93 1870 ROR LINE1,X
9549- 66 E3 1880 ROR *CHAR :BIT 4
954B- 7E CD 93 1890 ROR LINE2,X
954E- 66 E3 1900 ROR *CHAR :BIT 5
9550- 7E CD 93 1910 ROR LINE2,X
9553- 66 E3 1920 ROR *CHAR :BIT 6
9555- 18 1930 CLC
9556- 66 E3 1940 ROR *CHAR :BIT 7 = 0
9558- 38 1950 SEC
9559- 66 E3 1960 ROR *CHAR :BIT 8 = 1
955B- A5 E3 1970 LDA *CHAR
955D- 20 02 C1 1980 JSR DRIVER :PRINT
9560- A9 00 1990 LDA #0
9562- 85 E3 2000 STA *CHAR
9564- 88 2010 DEY
9565- 10 D0 2020 BPL DUMPY
9567- 60 2030 RTS
9568- 7E 81 93 2040 TRANS ROR LINE0,X :FINISH BYTE
          2050 :AND START NEXT

```

Listing 3 (Continued)

```

956B- 66 E3 2060 ROR *CHAR
956D- 7E 82 93 2070 ROR LINE0+1,X
9570- 66 E3 2080 ROR *CHAR
9572- 7E A7 93 2090 ROR LINE1,X
9575- 66 E3 2100 ROR *CHAR
9577- 7E A8 93 2110 ROR LINE1+1,X
957A- 66 E3 2120 ROR *CHAR
957C- 7E CD 93 2130 ROR LINE2,X
957F- 66 E3 2140 ROR *CHAR
9581- 7E DE 93 2150 ROR LINE2+1,X
9584- 66 E3 2160 ROR *CHAR
9586- 18 2170 CLC
9587- 66 E3 2180 ROR *CHAR :BIT 7 = 0
9589- 38 2190 SEC
958A- 66 E3 2200 ROR *CHAR :BIT 8 = 1
958C- A5 E3 2210 LDA *CHAR
958E- 20 02 C1 2220 JSR DRIVER :SEND TO PRINTER
9591- A9 00 2230 LDA #0
9593- 85 E3 2240 STA *CHAR
9595- 60 2250 RTS
9596- 2260 BASE .DS 2
9598- 2270 SAVBAS .DS 2
959A- 2280 LINE .DS 1
959B- 2290 SLIN .DS 1
959C- 2300 CURLIN .DS 2
          2310 .BA #9381
9381- 2320 LINE0 .DS 38
93A7- 2330 LINE1 .DS 38
93CD- 2340 LINE2 .DS 38
          2350 .EN

```

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SPEECH RECOGNITION

COGNIVOX recognizes words (such as "one," "enter," etc.) or short phrases (like "total amount," "net weight," etc.) from a vocabulary of 32 entries. The vocabulary entries are chosen by the user to suit his application. Then COGNIVOX is "trained" to the vocabulary by repeating each entry three times into the microphone under the prompting of the system.

During training, COGNIVOX analyzes the voice of the user and compresses all the important information in each entry into 48 bytes of data called the reference pattern. When training is complete, words spoken in the microphone are similarly analyzed and the resulting 48-bit pattern is compared with all the reference patterns to obtain a best match.

The power of COGNIVOX is derived from proprietary pattern generation and pattern matching algorithms that allow quick and easy training and give a recognition accuracy equal to much more expensive units.

Vocabularies larger than 32 words are possible by swapping reference patterns in memory using a key word, for example, "change vocabulary." Or the swap can be performed under program control.

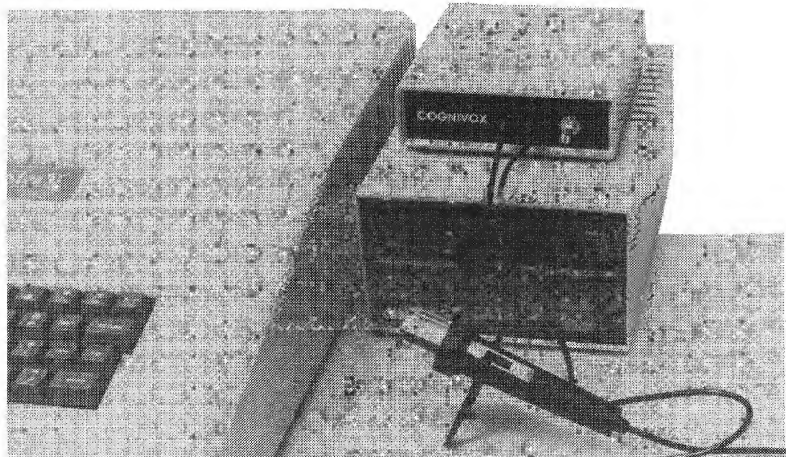
VOICE OUTPUT

COGNIVOX can talk with a vocabulary of 32 words or short phrases. No restrictions are placed on the vocabulary which can be programmed simply by saying the words into the microphone. The speech waveform is then digitized using a data compression method and stored in memory.

When voice output is desired, the selected word or phrase is reconstructed and played back using a built-in speaker/amplifier. A jack is also provided that allows connection to external amplifiers or speaker.

This method of voice output offers two very important advantages: First, the user has full control over the selection of the vocabulary and the type and tone of voice. Second, the voice output is naturally sounding human speech which is pleasant and easy to understand. These features are not available in most other voice output devices in the market.

The voice output and speech recognition vocabularies are independent of each other and can be different. Thus it is possible to establish a dialog with the computer.



USING COGNIVOX

COGNIVOX is designed for extreme ease of use. It is a complete system, fully assembled and tested, including hardware in an instrument case, microphone, power supply, cassette with software and user manual. It plugs into the game I/O port in the APPLE II and does not use up the valuable peripheral slots.

Software provided with COGNIVOX include demonstration programs and two voice operated, talking video games. All programs are unprotected so that the user can examine and modify them.

An optional diskette for DOS 3.3 includes all cassette software plus disk facilities to store and retrieve vocabularies on disk.

Adding voice I/O to your own programs is very simple. A statement in BASIC is all that is needed to either recognize or say a word. Complete instructions on how to add voice to your programs are given in the manual.

APPLICATIONS

COGNIVOX adds a whole new dimension to man-computer interaction. It can be used for data and command entry when hands and/or eyes are busy. As an educational tool. As an aid to handicapped. As sound effects generator. As a telephone answering machine. As a talking calculator, or talking clock.

The list is endless. With a BSR home controller interface it can be used to control by voice appliances and lights around the house. With an IEEE 488 interface card it can be used to control by voice instruments, plotters, test systems. And all these devices could talk back, saying their readings, alarm conditions, even their name. Finally, COGNIVOX is a super toy, a fascinating device to play with. Imagine an adventure game that talks to warn you of danger and listens to your commands!

SPECIFICATIONS

Recognizer type:

Isolated word, speaker dependent.

Vocabulary size:

32 words or short phrases for both recognition and voice response.

Dialog capability:

Recognition and response vocabularies can be different.

Word Duration

Greater than 150 ms and less than 3 seconds.

Silence gap between words:

150 ms minimum.

Training required:

Must pronounce vocabulary 3 times to train recognizer. Allows words to be individually retrained.

Recognition accuracy:

Up to 98%. Recognition accuracy depends on speaker experience and choice of vocabulary.

Type of voice output:

Digital recording of user voice.

Audio output:

130 mW

Frequency response:

100 to 3200 Hz.

Power consumption:

120 mW during recognition, 350 mW maximum during speech output.

Power supply:

9V DC, 300 mA, unregulated.

Dimensions:

5" x 6" x 1.25"

Memory requirements:

Approx. 4K bytes for program and tables. 1.5K bytes per sec. of speech for storage of voice response vocabulary (Approx. 700 bytes per word).

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Microbes and Updates

Jim Sherman of Huntsville, AL, called in with these corrections to "Saucer Launch" by Mike Dougherty (42:53):

On page 59 the listing is out of order. Lines 108E through 1092 belong at the bottom of the page (after line 108C). On page 60, line 10D2 should read: F0 06 BEQ NOXP.

Here are a few corrections to the RUNZMENU article by Frank Shyja (45:67):

On page 68 in the far right column, the third line of BCDF should read:

85 39 20 51 A8 A9 **8C** 8D 6D
BA8D should read:

D2 D5 CE DA CD C5 CE D5 **BF**

Erken Heinzjosef from West Germany wrote in with this update:

In MICRO 43 you published a Call Routine for the Superboard. Although it is very good, I have found a simpler way. My routine is only nine bytes long but it has a disadvantage: you cannot use hex addresses. But you can use

labels! See listing 1 for the machine-language routine and listing 2 for the equivalent BASIC load. The syntax must be

Z (or any alpha) =
USR (any argument) 65030

or

Z (or any alpha) =
USR (any argument) SC

The label "SCREEN CLEAR" gives syntax error as BASIC thinks it should be SQR.

65030 = hex FE06 = Screen clear in the C 1 S Monitor ROM from Aardvark. If you use labels, don't forget to define the label:

10 SC = 65030
20 WARMSTART = 0
30 X = USR(X) SC
40 X = USR(X) WARMSTART

You have to set the USR Vector at first by POKE 11,64: POKE 12,2. My BASIC load does it, but after a BREAK you have to reset the vector.

Listing 1

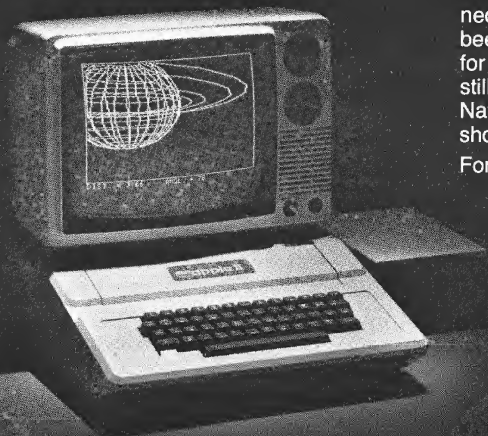
```
10 0000      :CALL-ROUTINE FOR SUPERBOARD
20 0000      :
30 0000      :H. J. Erken, West Germany
40 0000      :
50 0000      :
60 0000      :Addresses can be decimal values or labels
70 0000      :
80 0000      :To use, first set up the USR Vector by
90 0000      :POKE 11,64:POKE12,2
100 0000     :
110 0000     :
120 0240     * = $0240
130 0240     :
140 0240 20ADAA JSR $A0AD      ;Evaluate any expression
150 0243 2008B4 JSR $B408      ;Convert floating to fix
160 0246 6C1100 JMP ($11)      ;Hex value of expression is
170 0249                      ;stored in $11/$12
```

Listing 2

```
10 REM CALL FOR SUPERBOARD
20 REM H.J. ERKEN, WEST GERMANY
30 REM
40 FOR X = 576 TO 584
50 READ A: POKE X,A: NEXT
60 POKE 11,64: POKE 12,2: REM INIT OF USR FUNCTION
70 NEW
80 DATA 32, 173, 170, 32, 8, 180, 108, 17, 0
```

MICRO

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MICROTM

The Single Life

By Brad Rinehart

In my previous columns I have explained various HDE Disk BASIC features. This month I will cover some of the most unusual commands, as well as file handling techniques.

HDE Disk BASIC's more powerful commands include INSTR (in string), VARPTR (variable pointer), EXEC, MERGE, GET!, PUT!, PRINT USING, MKIS, MKS\$, CVI, and CVS.

The INSTR command returns the position of a search string within a target string. The syntax for the command is

```
VAR1 = INSTR ( VAR2, "STRING1",  
"STRING2" )
```

VAR2 is the character position within the target string where you begin searching. STRING1 is the target string and STRING2 is the key. VAR2, or the starting character position, is optional. If you omit it the search starts at the beginning of the target string. After you evaluate the function, VAR1 will contain the character position within the target string where the key was found. For example, if you have the string "THIS IS A TEST", and the key "IS", the statement

```
X = INSTR ("THIS IS A TEST", "IS")
```

will return the variable X with the value 3. You may have expected X to equal 6. However, the word 'THIS' contains an 'IS' in it. The statement

```
X = INSTR (4, "THIS IS A TEST", "IS")
```

will return X with the value 6. This time, we specified the fourth character as the starting point for the search.

The INSTR command also acts as the argument for an IF-THEN-ELSE statement.

```
IF INSTR("THIS IS A TEST","IS")  
THEN GOSUB 1000 : ELSE PRINT "NO"
```

will cause a GOSUB to line 1000. The statement following the ELSE will not

be executed. However, if you change this statement to

```
IF INSTR(7,"THIS IS A TEST","IS")  
THEN GOSUB 1000 : ELSE PRINT "NO"
```

control will pass to the ELSE statement and the word 'NO' will be printed to the screen.

The VARPTR command returns the memory address (in decimal) of:

1. The exponent of the variable A,
2. The least significant byte of the two-byte integer A%,
3. The byte defining the length of the string A\$.

To use this information, you must understand how BASIC stores variable data in memory. Numeric variables such as A and A% are stored in five-byte and two-byte locations, respectively. VARPTR will return the address of the beginning of this memory location sequence. In the case of string variables, a three-byte descriptor defines the string. The first byte is the length of the string in memory, and the second and third bytes are the address pointer to the string.

VARPTR may also be used to determine whether or not a variable exists. For example, if you study the statement

```
X = VARPTR (A$(1))
```

you will see that X will be returned with the value zero if the variable does not exist. Frequently, I need to know if an array has already been dimensioned. Without VARPTR, the only recourse is to redefine it and trap the error with an ON ERROR GOTO statement. I avoid ON ERROR GOTO statements; they make it too easy to build hidden 'BUGS' into a program.

The EXEC and MERGE commands each accept input from the disk as though it were entered from the keyboard. Either command accepts input from a SEQUENTIAL DATA file or a LIST# (ASCII) file.

The MERGE command enters program lines from the disk file as opposed to entering them from the keyboard.

This feature is useful when standard subroutines are to be used in several programs. For example, you may have a particular subroutine that is used to address the cursor on your terminal. Rather than manually entering the program lines each time you want to build a new program, the subroutine may first be entered from the keyboard, then LIST#ed out to a file called CURSR. Then whenever you want to use the subroutine within a program you simply enter MERGE "CURSR". This command, entered from the keyboard, will open the CURSR file and insert the lines into the program. You can save quite a bit of development time here!

The EXEC command will EXECute the command lines as they are read from the file. But with an EXEC file, the commands must be legal direct commands, such as PRINT, A=1, OPEN, CLOSE, PUT, and GET. Examples of commands that are not legal direct commands are INPUT and PRINT USING. Therefore, they may be used in files that are to be MERGED, but not in files that are to be EXECed.

The EXEC command is useful for repetitive tasks. For example, when you have several programs you want to list to the printer, you can create an EXEC file that will initialize the output device, load the first file, list it, load the next file, list it, and so on. This can all be done without any human intervention. Remember, any sequence of commands you enter repetitively from the keyboard may be put into an EXEC file and reused.

The EXEC command also accepts input from a string variable. This feature lets you build a command in the variable A\$, and then execute and EXEC A\$ command. Any string variable may be used. However, your commands may be no longer than 250 bytes. Of course, if several commands are to be EXECed, they could be constructed in a string array and executed in a FOR-NEXT loop as in:

```
FOR X = 1 TO 5  
EXEC A$(X)  
NEXT
```

(Continued on next page)

The Single Life *(continued)*

You might use this feature when you execute routines that are to be invisible to the user.

Some Printing Conventions

HDE has implemented a command, 'CALL', for directing output to peripherals such as printers and modems. The syntax for the command is CALL "DEVICE NAME", where the DEVICE NAME is a three character name associated with a binary or machine-language program stored on the system disk.

To use the CALL command you must either write or purchase the device driver program. This device driver is then SAVED to the system disk (drive 0 to 1). The CALL command will load and initialize the driver. With the driver initialized, output may be directed to the screen, the device, or both. To output to the device, commands such as PRINT, LIST, FIND, and LIB are followed by an exclamation point (!), as in PRINT!, LIST!, FIND!, and LIB!. To output to the screen, even while the device is enabled, eliminate the exclamation point. To disable the device, use the command CALL0 (call zero). Once the device is disabled, output from statements such as PRINT! will be directed to the screen. To change the output device from a printer to a modem, just execute another CALL with the proper device name as the argument, as in CALL "MOD".

You may want to write a driver that accepts input from a modem or another terminal. Then when you want to pass control to that device, just initialize it with the CALL command.

PRINT USING may be used to manipulate string data. If you consider that A\$="FRED", B\$="SMITH", then the statement

```
PRINT USING "PAY TO !! %    %";  
A$";B$
```

will print PAY TO F. SMITH to the terminal. To dispatch this to an output device, use the statement:

```
PRINT! USING "PAY TO !! %    %";  
A$";B$
```

The exclamation point after the PRINT command directs the output to the external device that was initialized with the CALL command.

PRINT USING allows seven different types of format identifiers for dealing with numbers. The pound sign is used exclusively for defining the field width of a number. The PRINT USING command in conjunction with the pound sign causes number fields to be right-justified. For example, if you wish to print a column of numbers beginning at position 50 on the page, you could use the command:

```
PRINT TAB(50); USING "#####. #"; N
```

The use of the comma in the field specifier will cause a comma to be output every three places in the number. Your printout might look like:

```
123,456  
232  
1,508
```

If decimal positions are to be defined, simply use the command

```
PRINT TAB(50); USING "#####. #. ##"; N
```

and the column will be right-justified, rounded to two decimal places, and zero-filled on the right.

```
123,456.25  
232.00  
1,508.07
```

File-Handling Techniques

Along with these unique commands, I want to introduce some of HDE Disk BASIC's file-handling techniques. There are three types of data files: SNAPSHOT, SEQUENTIAL, and RANDOM access. In addition, you have the ability to create an ASCII file of the program listing using the LIST# (list pound sign) command.

The main difference between the different types of data files is the way the data is stored on the disk and the techniques used to access it. First of all, the snapshot data file is, as its name implies, a snapshot of all the data in memory. If you can picture being able to grab the data in memory, compress it into one block, and then write it to the disk, you can understand the operation of this file. It is most useful when saving analytical data. For example, if

you are accumulating data and monitoring the results of laboratory tests, but need something recorded quickly, the command SAVED "TEST1" (meaning "save data") will, in a matter of seconds, write the contents of every variable to the disk file TEST1. To reload the information for later analysis, simply execute the command LOAD "TEST1" and memory will be restored to its previous contents.

With the RANDOM access file you can randomly access records within the file *without* reading or writing any other part of the file. This provides quick access to any record in the file.

The SEQUENTIAL data files are useful for data such as tax tables, rate tables, etc. Sequential files are best used when data fields or records are of varying lengths. Normally this type of data is manipulated in memory then written to the disk file when the user has completed working with it. The disadvantage of sequential file use is that to read the last record in the file, you must read the entire file. The same is true when changing one record in the file: you must read the file, make the change, and rewrite the entire file. But sequential files are usually more compact than RANDOM files.

To use sequential files properly, you must understand the structure of the file. First, records within the file may be terminated by a carriage return character (\$OD), a comma, or, when dealing with numerical fields, a space. The end of the file is signified by an end-of-file, or EOF mark. If you could look into the disk, you might find any of the following structures in a sequential file:

```
THIS IS RECORD 1$OD THIS IS  
RECORD 2$ODEOF 22 33 44 $OD 11 66  
55 $OD 13 $OD 99 21 $ODEOF 22, 33,  
- 44$OD 11, 66, 55$OD 13$OD  
99, - 21$ODEOF "THIS IS RECORD  
1"$OD"THIS IS RECORD 2","THIS IS  
RECORD 3"$ODEOF
```

The first two files were created using the PRINT# command, the second two using the WRITE# commands.

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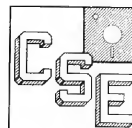
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Would you believe that you can run FLEX, OS-9 and Radio Shack disk software on the same Color Computer, and all you have to do is change the disk? That's right, just change the disk. If you have a 32K Color Computer with the Radio Shack disk system, all you need to do is make a trivial modification to access the hidden 32K, as described in the Feb. issue of COLOR COMPUTER NEWS and the April issue of '88' Micro. You can get FLEX from us right now. OS-9 will be ready by summer. Please note that this will only work with the Radio Shack disk system and 32K/64K memory chips that RS calls 32K. Maybe they put 64K's in yours, too. If you don't have a copy of the article, send a legal size SASE (40¢ stamps) and we'll send it to you.

Using this system to run FLEX and OS-9 has many advantages. First, it gives you 48K from zero right up to FLEX. This means that ALL FLEX compatible software will run with NO MODIFICATIONS and NO PATCHES! There are no memory conflicts because we moved the screen up above FLEX which leaves the lower 48K free for user programs.

What you end up with is 48K for user programs, 8K for FLEX and another 8K above FLEX for the screens and stuff. We have a multi screen format so you can page backward to see what scrolled by and a Hi-Res screen that will enable us to have 24 lines by 42 character display is on the way. That's better than an Apple!

We also implemented a full function keyboard, with a control key and escape key. All ASCII codes can now be generated from the Color Computer keyboard!

We also added some bells and whistles to Radio Shack's Disk system when you're running FLEX or OS-9. We are supporting single or double sided, single or double density, 35, 40 and 80 track drives. If you use double sided drives, the maximum is three drives because we use the drive 3 select for side select. When you are running the Radio Shack disk, it will work with the double sided drives but it will only use one side and only 35 tracks. Using 80 track RAM is okay, but will not be compatible with standard Radio Shack software. You can also set each drive's stepping rate and drive type. (SS or DS -SD or DD)

In case you don't understand how this works, I'll give you a brief explanation. The Color Computer was designed so that the roms in the system could be turned off under software control. In a normal Color Computer this would only make it go away. However, if you put a program in memory to do something first (like boot in FLEX or OS-9), when you turn off the roms, you will have a full 64K RAM System with which to run your program (FLEX or OS-9). When the roms are turned off, it is as if you had removed them from the computer. They are gone!

Now, we need the other half of the 64K ram chips to work, and this seems to be the case most of the time, as the article states. Of course, you could also put 64K chips in.

Some neat utilities are included.

MOVEMOM moves Color Basic from ROM to RAM. Because it's moved to RAM you can not only access it from FLEX, you can run it and even change it!! You can load Color Computer cassette software and save it to FLEX disk. Single Drive Copy, Format and Setup commands are also included.

Installing FLEX is simple. Insert the disk and type:

RUN "FLEX"

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Commodore and MICRO

by Loren Wright

Commodore has been a dominant force in the microcomputer world since the Personal Electronic Transactor (or PET) was introduced in 1977. The first PETs admittedly had their problems. The small keyboard, a holdover from Commodore's calculator background, gave the PET a toy-like appearance. There was no resident machine language monitor — a tape version had to be loaded into RAM each time. There were also a few problems, of varying annoyance, in the operating system. Documentation had to be obtained from users' groups, since Commodore would not, and perhaps could not, provide very much.

In the U.S., the PET came out in the face of stiff competition from Apple and Radio Shack. The Apple attracted many people with its high-resolution color and full-size keyboard, while Radio Shack, with its nationwide network of stores and well-organized marketing effort, drew even more attention. To compound their problems, Commodore attempted to sell the PET only directly or through its Mr. Calculator stores, and there were delivery delays of many months.

The PET, as many other computer shoppers recognized, offered a system complete with CRT display, cassette mass-storage, and fully implemented BASIC for a price less than comparable systems from either Apple or Radio Shack. In the rest of the world, where Commodore was organizationally better equipped to compete, the PET became (and still is) the number one microcomputer.

The company corrected most of the problems with a new operating system. Unfortunately, this was done without much consideration for those who had already invested a lot of time and money developing commercial software for the old operating system. Many people abandoned ship at this point, but most adjusted and are still loyal PET owners. Since then, there has

been yet another operating system introduced, but this time the changes were far less radical, and Commodore cooperated considerably more in the transition.

To understate the situation, Commodore has been unpredictable in its approach to the market. When the 80-column business machine and the VIC were announced, there were widespread fears that the company would abandon PET owners in favor of the more lucrative entertainment and business markets. So far, those fears have not been justified. It is clear now, particularly with the announcement of several new computers, that Commodore wants to compete in all microcomputer markets. The new line-up will apparently include the Ultimax, the VIC, the SuperVIC, the PET, the 8016/8032, the color 8032, the Commodore-64, the SuperPET, and the 8096. Each of these is aimed at a particular segment of the market.

If its new advertising campaign is any indication, Commodore intends to provide the best value for any microcomputing need. The company plans to accomplish this not by inventing radically new computers, but rather by producing variations on its PET and VIC themes to compete over the full range of the market. To quote Jack Tramiel, the man behind Commodore, "We will become the Japanese!" — meaning that they will offer a lower-priced alternative. Whether Commodore can actually accomplish its goals is still uncertain.

MICRO has been covering the PET since its inception. Much of our job in the early days was to provide the information not provided by Commodore, and to help PET owners get around the bugs in their systems. Things have progressed much further than that now. The PET system is virtually bug-free and good documentation is available not only from Commodore, but from a

number of other sources. We will continue to publish articles of special interest to PET users, but you will find many of our other articles valuable as well. More articles written for other computers will be accessible to PET users, and we will continue to expand your horizons with material on new programming techniques, languages, and applications.

This issue's feature article "Growing Knowledge Trees," by David Heise, introduces artificial intelligence to MICRO readers. While it is written especially for the PET, I recommend that all MICRO readers try to see this program in operation. It should provide some ideas for your own artificial intelligence programs.

"Menu and Tape Timer," by Dale DePriest is a sequel to last month's "A Real Tape Operating System." In that article he discussed the good and bad features of the PET's tape system and presented some techniques to get the most from that system. This month's programs will help you turn your cassette collection into a well-organized file retrieval system. Although a disk drive is faster and more convenient, the PET's cassette system, with a few refinements, can offer a considerably less expensive alternative, which is still very satisfactory.

Louis Sander's "PET Memory Protector" is a simple circuit that is inserted between one of your PET's static RAM chips and its socket. Depending on where it is installed, PMP protects 1K or more of RAM from BASIC, LOADs and resets. The reset button, which is part of the circuit, can be used for either a cold or a warm reset.

MICRO



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```
100 GOSUB 180
105 PRINT USING C$, A, B$
130 INPUT "TIME": D$
131 INPUT "DAY": E$
160 IF B$ = C THEN 105
180 FOR X=1 TO 9
183 PRINT Y(X):NEXT
184 RETURN
200 I=X/19
READY
RENUMBER 110, 10, 105-184
READY
LIST
100 GOSUB 150
110 PRINT USING C$, A, B$
120 INPUT "TIME": D$
130 INPUT "DAY": E$
140 IF B$ = C THEN 110
150 FOR X=1 TO 9
160 PRINT Y(X):NEXT
170 RETURN
200 I=X/19
READY
```

```
MERGE D1 "BUY NOW"
SEARCHING FOR BUY NOW
LOADING
READY
RENUMBER 100, 10
READY
FIND B$
110 PRINT USING A$, B$, C$, D$, E$
280 B$="NOW IS THE TIME"
READY
```

```
500 BA=BA-1
590 RA=123*5X/92+BA*10
600 IF BA=143 THEN 580
610 RETURN
620 C$="PROFIT $#, #### DAILY"
630 PRINT USING C$, PI
640 D$="LOSS $#, #### DAILY"
650 PRINT USING D$, LI
RUN
PROFIT $1, 238.61 DAILY
LOSS $ 0.00 DAILY
READY
```

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PET Memory Protector

by Louis F. Sander

This easy-to-build add-on for 8K PETs selectively isolates 1K or more of memory from BASIC and from resets. The protected area is an ideal repository for monitors or other machine-language programs.

PMP

requires:

PET with socketed 6550 or 2114 RAM chips (all small-keyboard PETs, except the most recent release) and a number of electronic parts.

PET users have a shortage of protected memory for machine-language programs. The PET Memory Protector is a simple add-on device that eliminates this shortage. In a typical PET, only the second cassette buffer, with its meager 192 bytes, is out of reach of BASIC, resets, and LOADs. The only way to protect an area in high memory is to do several zero-page POKEs, an annoying task. The PET Memory Protector, or PMP, provides a simpler and more reliable way to reserve 1K blocks of high memory for machine-language programs or any other use.

PMP is activated by momentarily depressing one switch, eliminating the need for memory-reserving POKEs. BASIC cannot write into the PMP-protected area unless specifically directed, and LOADING a tape from either cassette does not affect it. The PMP includes a reset function that allows selection or deselection of memory protection while the reset is performed, all with one simple control.

Installation of the PMP requires no drilling or cutting of the PET, and no soldering to any PET component. You simply insert the PMP connector between one memory chip and its socket,

and mount the PMP switch in existing holes in the PET. The typical installation protects 1K of memory, but larger 1K multiples can be protected simply by moving the PMP connector. The present version of the PMP will work only with PETs using the type 6550 or 2114 RAMs in plug-in sockets (basically, all the small-keyboard machines). Work is in progress on a version for the large-keyboard machines. Construction of a PMP is not difficult for an experienced electronic builder; non-builders can purchase a fully assembled and tested version from the authors.

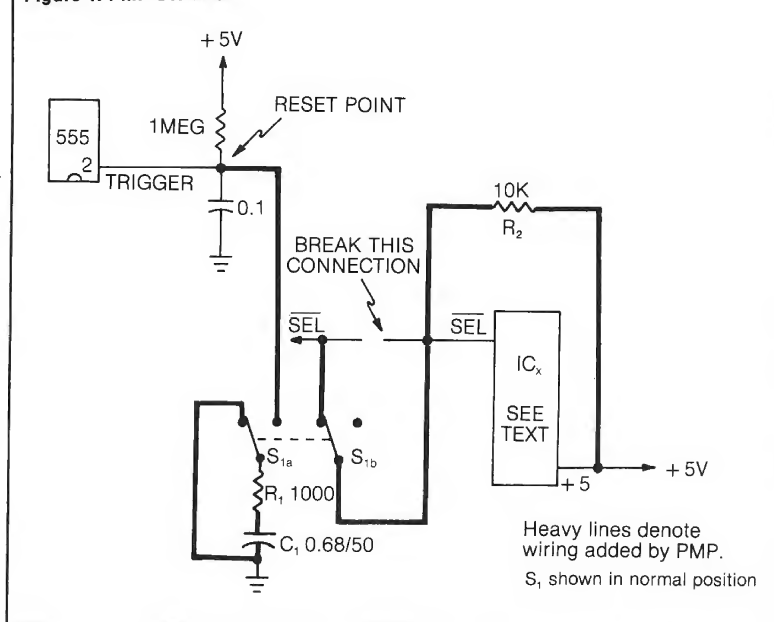
Theory of Operation

Figure 1 is the schematic diagram of the PMP. When S_1 is closed, it connects R_1 and C_1 to the trigger pin of PET's power-up timer, and opens the chip-select line to IC_x . IC_x can be any one of

PET's RAM chips; typically it will be one of the two that constitute the top 1K of user RAM. The charging effect of C_1 momentarily lowers the voltage on the timer trigger pin, which activates the timer and a power-on reset. At the end of the timer's one-second cycle, PET writes a character into the lowest memory location of the user program area, then reads the contents of that location. If the read and write are identical, PET repeats the process at the next higher memory location. The first time the read and write do not match, PET concludes that it has passed the top of available RAM. It then sets its zero-page BASIC pointers accordingly, and puts the appropriate BYTES FREE message onto the CRT.

If S_1 is still actuated when the reset routine tries to write into IC_x , the \overline{SEL} line will still be broken by S_{1b} and the

Figure 1: PMP Schematic



PET FEATURE

\overline{SEL} pin will be held high by the voltage from R_2 . So the read/write process into IC_x will fail, and PET will conclude that IC_x and all memory above it does not exist. Because IC_x is paired with another chip that is not disabled by S_1 , the reset will have modified the lowest single byte in IC_x , but will not have affected any higher memory locations. The BYTES FREE message will include only those memory locations below IC_x . S_1 can be released as soon as the BYTES FREE message appears, and at that time IC_x will be fully functional, but BASIC will not know that it is there. In other words, IC_x and above will constitute a fully protected area of memory.

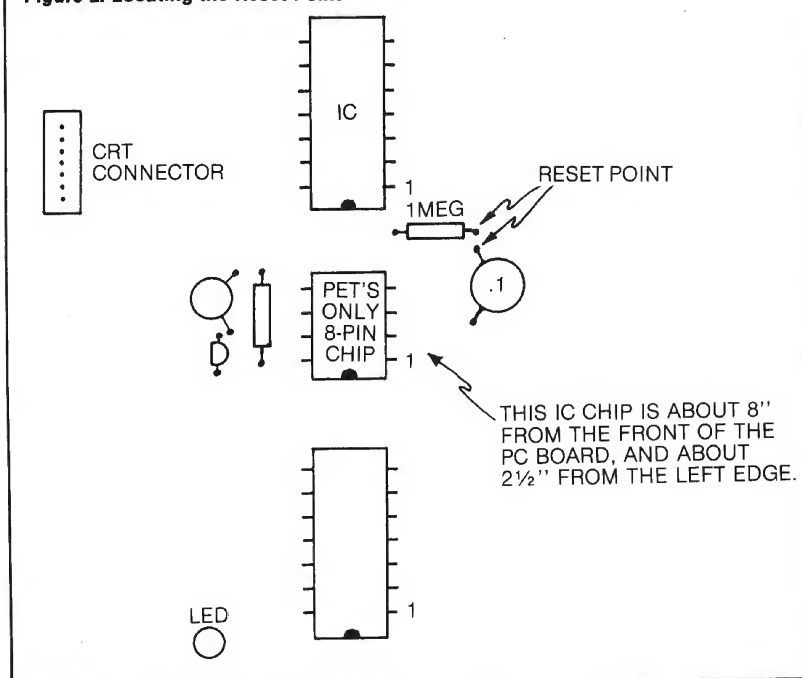
If S_1 is released before the timer finishes its cycle, IC_x will be properly connected when PET attempts to access it. The reset process will proceed normally, writing over any information in IC_x and above, and including those locations in the BYTES FREE message. IC_x and above will not be protected memory. In either case, as soon as S_1 is released, C_1 will discharge through R_1 , to be ready for the next reset.

Construction

If you are not an experienced electronics builder, you shouldn't try this project on your own, since a miswired PMP could mean disaster to your PET. For the builder with any experience, PMP construction is straightforward, except for breaking the \overline{SEL} line to IC_x . For the 6550, \overline{SEL} is pin 18, and +5 is pin 17. For the 2114, \overline{SEL} is pin 8 and +5 is pin 18. Make up a "PMP connector" from two wire-wrap IC sockets. Plug the sockets together, piggyback-style, and cut the pin carrying the \overline{SEL} lead from one socket to the other. If you want to do a more professional job, use one wire-wrap socket and the plastic base from another, cutting one of the pins. Either way, solder your S_{1b} leads to the severed ends, and glue everything together so it can't move. Solder R_2 to the appropriate pins of the upper socket, and you're in business. (You need wire-wrap-type sockets for this work, because the solder-tab-type pins are too short to work with, unless you're used to microsurgery.)

We advise the prospective builder to be persistent in his search for parts, since S_1 and the IC sockets are not common items. They are manufactured by the thousands for industrial use, but your local Radio Shack doesn't carry them.

Figure 2: Locating the Reset Point



Installation

The first step in installation is to unplug your PET. Then find a way to mount S_1 permanently. You can either drill a hole in your PET, or drill a $\frac{1}{2}$ " \times 3" strip of heavy sheet metal to accept S_1 . Then mount it to the cover hold-down bracket on PET's right side, using two additional holes drilled through your piece of sheet metal. If S_1 is properly chosen, it will easily fit in the $\frac{1}{2}$ " space between PET's cover and base, making a very attractive and unobtrusive installation.

Next, connect the wire from S_{1a} to the reset point. Here you can solder a wire directly to PET's circuit board, or you can use a tiny test clip to connect it to a component lead. The reset point is easy to find by locating the 555 timer chip, which is the only eight-pin IC in the PET. It's on the far left side of the printed circuit board, about eight inches from the front edge. The reset point is accessible either at pin 2 of the 555, or at the resistor or capacitor lead wire shown in figure 2. (By the way, this is the same point used by the reset buttons on old ROM PETs.)

Finally, locate IC_x and put the PMP connector between it and its socket. At the very front of the main printed circuit board are two identical rows of eight IC chips in sockets; this is PET's RAM. Each 1K of memory is made up

of one IC in the front row, plus its partner in the second row. Half a byte is stored in each chip, for 1024 memory locations in each pair.

If your memory chips have 18 pins each, they are 2114's, and the IC's making up the lowest memory locations are to the far left. The highest memory locations are to the right. To protect 1K of memory, the PMP plugs into either one of the rightmost chips. With 2114's the PMP can be plugged into any RAM socket, protecting any number of 1K memory blocks.

If your memory chips have 22 pins, they are 6550's, and things work differently. The low memory locations are to the right in this case, and the high ones are to the left. Your PMP will only work properly in the highest 1K (the leftmost socket), or the highest 4K (number 4 from the left).

To locate IC_x , first determine how much memory you want PMP to protect. If it's 1K, then IC_x is the rightmost or leftmost IC in the front row. If you want to protect 2K of memory, IC_x is the chip just next to that one, and so on, at the rate of 1K per chip. For test purposes, you will need to protect 1K, so initially use the end chip in the front row. Use the left chip for 6550's, or the right chip for 2114's. (In every case, the corresponding chip in the second row could be used, with identical effect.

We've arbitrarily chosen the front row chips because they're easier to get to.)

Before removing IC_x, note the U-shaped depression on its top at one end. That is an orientation mark, and when it faces you, with the IC pins pointed downward, pin 1 is the closest pin to you on the right. See figure 2 for examples. Take careful note of IC_x's orientation, so that you'll be able to insert the PMP connector and IC_x in the proper direction.

When you've done this, gently pry IC_x from its socket, using a small screwdriver inserted from the front. Use standard static protection techniques: keep yourself grounded, and lay the naked IC, pins downward, on a piece of foil or conductive foam. Now insert the PMP connector into the vacant socket, being extremely careful to preserve proper orientation. Using static protection techniques, and once again paying careful attention to orientation, insert IC_x into the PMP connector, and you're ready to test your PMP.

Test and Operation

Visually inspect the installation to make sure there are no broken wires or short circuits. Make sure that the PMP is plugged into the correct socket, and that all its pins are making contact. (Look closely, as bent pins are common, and easy to miss.) Make the same check on the IC chip, where it plugs into the PMP. Finally, double check the orientation of the IC and the PMP; if either one is in backwards, correct it immediately.

When you're certain that everything is as it should be, turn on the power to your PET. You should get the normal BYTES FREE message (7167 bytes on the 8K PET). Now load a machine-language program (MLP) of some sort into the top part of the top 1K of memory. Ideally, it should extend to the very last free byte. Be sure your program doesn't use the very first byte of the top 1K, since that byte will be modified by the reset routine. Run your MLP to make sure that it works.

Now activate S₁, and keep it activated until the BYTES FREE message appears once again. If all has gone well, that message will have appeared about one second after you first activated S₁, and will indicate 1024 fewer bytes than normal. Next, LOAD and RUN a BASIC program that uses several string variables. Run your MLP once again. If both programs work properly, PMP has protected upper memory from being written into by BASIC.

Parts List

C₁ — 0.68 F, 50 wv

R₁ — 1000 ohm, ¼ watt

R₂ — 10K ohm, ¼ watt

S₁ — DPDT momentary toggle or pushbutton switch

Two 18-pin or 22-pin wire-wrap-type IC sockets (pin configuration depends on your RAM type)

Hookup wire

Glue (Devcon clear epoxy or similar)

Optional ½" × 3" piece of heavy sheet metal (for switch mounting bracket)

Total parts cost should be \$10-\$12 for top-quality, name-brand parts.

For the final test, momentarily activate S₁, this time being sure to release it before the BYTES FREE message appears. If you get a normal BYTES FREE message, and if both programs are gone from memory, your PMP is working correctly. Congratulations on a job well done!

Now here's the full story on clearing and protecting memory in your PMP-equipped machine.

1. POWER ON clears all memory, overwriting it with characters dictated by your ROM set.
2. Using either cassette drive to LOAD, SAVE, or VERIFY clears the associated cassette buffer, replacing what was there with data from the tape header. The unused cassette buffer is not affected.
3. Momentarily depressing S₁ and releasing it before the BYTES FREE message appears clears all memory *except* the cassette buffers, and gives a normal BYTES FREE message. The cleared memory is overwritten with characters dictated by your ROM set.
4. Holding S₁ until the reduced BYTES FREE message appears clears all memory *except* the two cassette buffers and the memory above the first protected byte. That first byte will be altered by the reset process, but is protected afterward. Anything previously existing above that byte will be unaffected by the reset, and will

be protected from being written into by BASIC. It can be PEEKed and POKEd, but that is all.

That's the full story on the PET Memory Protector. We've found it to be a very handy device for protecting high memory, and we hope that you will, too. If you'd like to have a fully assembled and tested PMP, we've made some up that we'll send you for \$20 each. Just send your name, address, and RAM type to: Louis F. Sander at 153 Mayer Drive, Pittsburgh, PA 15237.

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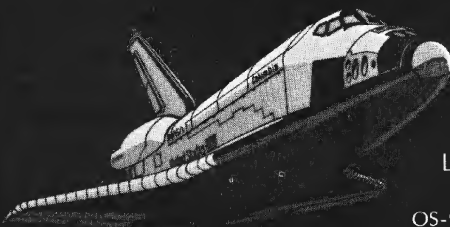
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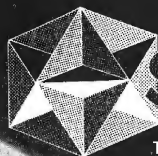
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Growing Knowledge Trees

by David R. Heise

Knowledge can be represented in tree diagrams that are stored and analyzed by computers. This PET program finds out what people know about a topic, analyzes answers, and shows users the organized results.

"Knowledge Trees"

requires:

16K or 32K PET

3.0 Operating System

Printer and disk drive are supported, but optional. Notes are provided for 1.0 and 4.0 conversion.

A computer needs to be knowledgeable if it is to help you classify plants, diagnose illnesses, or identify beliefs that hold down productivity. But how do you make a computer knowledgeable? How do you teach a computer what an expert knows? How do you represent knowledge?

Research on these questions has been performed in computer science specialties like data base management and artificial intelligence, and also in social sciences like anthropology, sociology, and cognitive psychology. Data base management systems and psychological research demonstrate that some kinds of knowledge can be stored as associative networks with pointers linking items to related items. As a sociologist, I've shown that measurements about actors and behaviors can be used mathematically to generate information about social events. Artificial intelligence research and contemporary anthropology often represent knowledge as hierarchical trees of relationships.

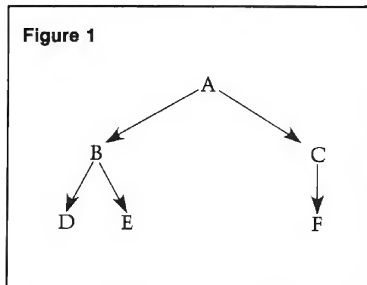
This article discusses the tree concept for knowledge representation and presents a program that turns a Commodore microcomputer into a machine

for gathering hierarchical knowledge from people and reducing it to its simplest form. The program illustrates how to pass multiple parameters to an assembly-language subroutine via the USR function in BASIC. It shows you how to create a BASIC subroutine that can call itself recursively, and demonstrates a method for automatically loading and protecting assembled code, along with a BASIC program. Assembled routines are provided for carrying out operations on trees.

Data Structures

Hierarchical knowledge can be represented in a tree diagram, which is a type of directed graph. See figure 1.

Figure 1



Letters A through F represent *nodes* in the graph. These are the entities involved in hierarchical relationships. For example, the nodes could be A = living creature, B = mammal, C = bird, D = dog, E = cat, and F = robin.

The arrows are called the *edges* of the graph. All of the arrows on a graph represent a certain relationship. For example, in figure 1, each arrow could represent the relation "is a kind of." Thus, reading backward along an arrow, we see that B is a kind of A. Different arrows show which entities are related to other entities. In general, the node at the top of an arrow is a *superordinate* of the node at the bottom of the arrow. The node at the bottom of an arrow is a *subordinate* of the node at the top.

Relations in a tree diagram are *transitive*. This means that a relationship between two entities can be inferred when they are connected by a chain of arrows rather than by a direct arrow. For example, in figure 1, D (a dog), is a kind of B (mammal), and B (a mammal) is a kind of A (living creature). Therefore we can infer "a dog is a kind of living creature" even though there is no direct arrow from A to D. Many kinds of relationships are transitive. For example, time ordering is transitive: if event B occurs after A, and C occurs after B, then C occurs after A. "Is part of" also is transitive: if B is part of A, and C is part of B, then C is part of A. Some relations seem transitive but are not, like the relation "has." Jane may have a husband, and her husband may have a bald head. We would not want to conclude that Jane has a bald head.

Tree diagrams can be represented in matrix form. Figure 2 shows the matrix for the diagram in figure 1. Letters along the top of the matrix show nodes as originating sources for arrows. Letters along the side of the matrix show nodes as destination points for arrows. A zero in a cell indicates that no arrow connects the column node to the row node. A one indicates that an arrow goes from the originating node (column label) to the destination node (row label).

Figure 2

| | A | B | C | D | E | F |
|---|----------|----------|----------|----------|----------|----------|
| A | <u>0</u> | 0 | 0 | 0 | 0 | 0 |
| B | 1 | <u>0</u> | 0 | 0 | 0 | 0 |
| C | 1 | 0 | <u>0</u> | 0 | 0 | 0 |
| D | 0 | 1 | 0 | <u>0</u> | 0 | 0 |
| E | 0 | 1 | 0 | 0 | <u>0</u> | 0 |
| F | 0 | 0 | 1 | 0 | 0 | <u>0</u> |

The major diagonal is emphasized with underlining in figure 2. In a matrix that represents a hierarchical

tree, the major diagonal is always filled with zeros, and nodes can be ordered such that all entries above the major diagonal are zero. A *topographical ordering* of nodes has the node at the top of the graph first (A). Nodes that are directly connected to this node come next (e.g., C and B), then nodes directly connected to these follow (e.g., F, E, D), and so on, until all nodes are listed. A topographical ordering orders the nodes as they are encountered when going from the top of the tree diagram to the bottom. If nodes are listed in topographical order for the matrix representation, then all cells above the major diagonal contain zeros.

A tree diagram can be stored inside a computer in various ways. We could store the matrix representation, but this wastes space on zeros above the main diagonal. Instead we will use the *edge list* representation. This approach stores a tree, including verbal labels for the nodes, in two lists — name and edge — as shown in figure 3.

Figure 3

Name List

- (1) a living creature
- (2) a mammal
- (3) a bird
- (4) a dog
- (5) a cat
- (6) a robin

Edge List

- 1,2
- 1,3
- 2,4
- 2,5
- 3,6

The name list is simply a list of node labels with index numbers implied. Each entry in the edge list corresponds to an arrow on the tree diagram, and the entry consists of two numbers. The first is the index number for the arrow's originating node. The second is the index number for the destination node. The edge list has as many entries as there are arrows on the diagram. Their order is not important.

In the program presented here, index numbers are interpreted as ASCII values and converted to characters. Thereby the edge list can be maintained as a character string, taking advantage of dynamic string allocation in CBM BASIC; we do not have to set aside space for the edge list, whose size is unpredictable beforehand. By adding

64 to each index number before converting to a character, we get ASCII values for letters of the alphabet. For example, the edge list in figure 3 could be represented as the following string:

'ABACBDBECF'

This string contains all the information represented in figures 1 and 2. Marking the string off into pairs of letters precisely defines each arrow in the tree diagram.

We now have a neat, concise way of representing hierarchical knowledge in a CBM microcomputer. Artificial intelligence research usually employs a list representation that calls for a LISP language interpreter, but that would not be as convenient as this approach that works in BASIC.

Elicitation

The next step is to input knowledge from humans into computers. Storing knowledge within programs is not an efficient approach because too many people do not know how to program. Rather, the computer should elicit and store people's knowledge:

- accommodating to a user's interest in a certain kind of relation,
- talking with the user about a given topic,
- helping the user recall topical elements (nodes),
- helping the user to define relations among elements (edges).

Ideally the computer would deal with any kind of relation for making trees and would talk in accordance with rules of grammar and discourse. These kinds of flexibilities are costly in terms of program space, so we compromise. The program here offers three kinds of relationships for analyses, and presents only a limited number of queries.

Requirements for eliciting nodes and edges are more critical. To represent a person's knowledge about a topic, we must get as close as possible to an exhaustive listing of concepts (nodes). Furthermore, we must meticulously examine every possible relationship to assure that all real ones are included.

This program uses several tactics to help a person recall entities in the domain being considered. At the begin-

ning of a session, and periodically thereafter, a general elicitation question is presented, in the form: "What is an entity in the domain being considered?" The user is reminded of all the entities that have been entered already. Once some entities have been specified, these are used to stimulate recall of more entities, using questions like: "What other entities are related to entity X in the domain being considered?" Ultimately, every recorded entity is used as a stimulus for obtaining more entities. Additionally, the user occasionally is asked to name an entity that differentiates some entities from others, in a query like: "X, Y, and Z are entities in the domain of interest; what entity might be implied by two of these?" While no methodology guarantees exhaustive recall of all entities, these techniques do promote extensive recall.

Definition of a new entity's relations is complex because a number of conditions have to be fulfilled in building a tree. These conditions are:

1. As we consider a new entity, we have to allow that it could be subordinate to any existing entity, and/or superordinate to any entity except the top one (which defines the domain of interest). That is, a new node might be positioned anywhere in the tree diagram except above the top node. In principle, this means that for every existing entity except the topmost one, the computer has to ask the user whether the new entity is a superordinate and/or subordinate. Fortunately, principles of logic and transitivity permit economies.
2. The complexity of hierarchical knowledge requires allowing any entity to have multiple subordinates or multiple superordinates.
3. Finally, proper tree structure calls for deleting any relations that can be inferred from transitivity.

The program assumes that a new entity is subordinate to the top node — it is in the domain of interest. Then a series of yes-no questions is asked to determine which existing entities are superordinates or subordinates of the new entity. Each query is of the form: "Does X (an existing entity) imply Y (the new entity)?" "Does Y imply X?"

The entities that are superordinate to the new entity are determined first. Querying works from the top of the tree downward, the procedure considers existing entities in topological order.

Let's say an existing entity is not superordinate to the new entity. Then subordinates of that existing entity are not superordinate to the new entity because of the transitivity principle.

Once a new entity's superordinates are known, more questions are asked to find its subordinates. The procedure employs two logical principles that follow from transitivity. First, if a new entity, Y, is not subordinate to an existing entity, X, then the new entity cannot be superordinate to any of X's subordinates. For example, since a sparrow is not a kind of mammal, various kinds of mammals cannot possibly be kinds of sparrows. Thus, no queries need to be presented regarding subordinates of entities which are not superordinate to the new entity. To find all of a new entity's subordinates, we only need to ask about the subordinates of entities for which the new entity is itself a subordinate.

Second, once we discover that the new entity is superordinate to an existing entity, we know that it is superordinate to all of that entity's subordinates. We do not want to represent those relations directly since they are derivable.

"Knowledge Trees" is written for the PET's 'upgrade' or 3.0 operating system. Notes have been provided to modify it to run on 1.0 and 4.0 systems. With the changes indicated, the program should work on 1.0 PETs. However, to run properly on 4.0 PETs, changes to the machine language portion of the program, beyond those indicated for PET ROM routines, will be necessary.

The problem is in the infamous 'garbage collection' routine. To speed up garbage collection (the process of removing old copies of dynamic strings), the 4.0 ROMs store a back pointer after the actual string characters in high memory. The garbage collection routine checks these back pointers to be sure they point to valid string descriptors in low memory. Bad strings are wiped out. The "Knowledge Trees" machine language routines do not accommodate these back pointers, and as a result, the system is likely to crash when a garbage collection takes place. MICRO will publish a fix for this problem in a future issue.

The transitivity principle eliminates queries about many possible relations, thereby substantially reducing the labor in establishing a new entity's position in the tree diagram. However, the potential for multiple subordinates and multiple superordinates requires that we ask many questions that might seem unnecessary.

To illustrate, suppose that "house pet" is added to the tree represented in figure 3 (abbreviated in figure 1). A house pet is a living creature, but

queries establish that a house pet is not necessarily either a mammal or a bird. We then search for subordinates of house pet among the subordinates of living creature. Mammals are not all house pets, so mammal is not subordinate to house pet. Nevertheless, to avoid error, we must continue searching among the subordinates of mammal. It happens that dogs are a kind of house pet. Thus, in the new tree diagram, dog will be subordinate to both mammal and house pet; dog has two superordinates. Similarly, cat also

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is a subordinate of house pet. Having found these subordinates of house pet, we still must continue searching for other subordinates among the other subordinates of living creature. Searching through the bird subgraph yields no more subordinates in this example, but it would if we had canary as an entity.

Once all required queries have been answered, the program positions the new node by linking it to all of its immediate superordinates and all of its immediate subordinates. This is done by adding appropriate entries to the edge-list. If a superordinate and a subordinate of the new entity were originally connected by an arrow in the tree diagram, that relationship is deleted since it now can be derived using the transitivity principle.

Illustrative Analyses

One program option permits the analysis of the kinds of people at a scene. This elicitation provides a way to study people's subjective notions of social structure. The results can be related to issues of role identification, role conflict, and definitions of situations.

When the program has been loaded, the user is instructed on how to use the computer's keyboard. The user is given the instructions in exhibit 1 to read, and a sheet like exhibit 2 showing available commands.

The progression of questions and answers during the first part of a session might be as shown in exhibit 3. You might find a different structure if you did it yourself.

Choosing option 2 in answer to the first question would lead to the elicitation of happenings in an event. For example, analyzing what happens when we dine out might give the final results shown in exhibit 4. This elicitation could precede critical path analyses in order to define all the events that have to be considered. It also is an empirical approach to constructing "frames" for artificial intelligence research.

The BASIC Program

Input

The STOP key is disabled while the program is running (lines 340-350). A special input routine (lines 640-780) uses a shaded cursor to keep the program from ending if the user hits RETURN without making an entry. However, you can still break from a run

by typing SPACE, then RETURN. The STOP key's function is turned on and off again during the input routine, so STOP is available if you break out of the program for programming purposes.

In the introductory part of the program (lines 370-510), a menu allows the user to choose one of three kinds of analysis.

1. *Analysis of a social scene.* This option elicits social roles and orders them by the "kind of" relation.

Specifically, relations among roles are defined by asking "Is an X always a Y?" The name of the scene (the top node) and one role are elicited as part of the opening procedure (lines 880-1010).

2. *Analysis of an event.* Particular happenings are elicited, and then ordered in terms of their temporal priority: "Is X over before Y?" The definitional subroutine (lines 1030-1160) also gets the name of the general event (top node) and one specific happening.

Exhibit 1: Instructions

You can look at people in different ways. For example, the President of the United States is the President, a politician, a man, an adult, a husband, a father, and other things, too. Everyone can be seen in several ways.

How you see people depends a lot on where you see them. You might think of someone on the street as a pedestrian. The same person inside a store would be a customer or a browser or an employee. One idea about a person can lead to another. For example, teachers always are adults, so if people are talking about a teacher, you automatically know they are talking about an adult.

In this session with the microcomputer, you will name the scene you want to analyze. Thereafter the computer will ask you what kinds of people are found there, and how one type relates to another.

The machine begins by asking questions like, "Is a child always an adult?" But the computer learns what you tell it, so later questions are more interesting. In fact, you have to think carefully to answer some of them.

After you've named different types of people, the computer will analyze your answers and present the results in a chart. The chart has a row and a column for each type. Dots show which types are special cases of other types. For example, if professor and teacher were on the chart, a dot might appear in the professor row and the teacher column indicating that a professor is a kind of teacher.

Two dots in one column show what people have in common. For example, teacher and secretary might both have dots in an adult column, indicating that teachers and secretaries have adulthood as a bond between them. Two dots on one row suggest how a person might get confused in the situation. For example, professor might have a dot under teacher and another under researcher, indicating that sometimes a professor might feel torn between acting as a teacher and acting as a researcher.

Answer the first question by typing number 1 and pressing the RETURN key to analyze types of people.

The second question asks what kind of scene you want to analyze. Answer by typing a singular noun, like FAMILY, SCHOOL, or PARTY. Then press RETURN.

The next questions ask for types of persons you might find at the scene. Use just one or two words to name each type. Use nouns rather than adjectives — e.g., DUMMY rather than DUMB. Use singular rather than plural — e.g., TEACHER rather than TEACHERS. Type each name and press RETURN. If you misspell a word, you can correct it with the change command the next time you are asked to enter something.

Pretty soon the computer starts asking yes-no questions like, "Is a teacher always an adult?" Answer by typing Y or N. Answer yes-no questions for the ideal or general case. If you make a mistake while answering a yes-no question, continue answering Y until the yes-no questions are over. Then delete the entry with the change command so you can re-enter it correctly.

After the first few questions, the chart may appear automatically just before you name another type. When you are through looking at the chart, press the RETURN key, and the questions will start again. You also can get the chart by entering # instead of a name.

Enter \$ to skip a question, if you cannot think of a good answer. (The \$ option does not apply when answering yes-no questions.)

3. *Analysis of an entity.* Components of an entity and their incorporation relationships are elicited, using the relational question "Does X definitely have Y?" The name of the entity and of one of its parts are acquired while defining this option (lines 1180-1310).

Wordings of the various elicitation questions are adjusted for each option. You can change the wordings by changing the definitions of the string variables W3\$, W4\$, and W5\$ (e.g., in lines 980-1000).

After these preliminaries, the program drops into a loop which continually cycles through all of the existing nodes in the graph (lines 530-620). The loop has no termination: the program ends when you press SPACE RETURN or turn off the machine.

The subroutine eliciting new entries (lines 1430-1840) ordinarily presents one of the existing entries as a stimulus, asking a question like: "What else might X relate to in the entity?" Existing entries that relate are

listed as a reminder: "Aside from Y, Z?" The new entry is accepted, preceded by "a" or "an" (if that is appropriate), added to the name list, and another subroutine is called to place the new node in the tree.

Instead of entering a word in response to the elicitation question, the user can enter any of the program commands to correct, display, analyze, or save the data.

The main program loop calls a second elicitation subroutine (lines 2730-3010) that checks whether a node has more than two immediate subordinates. If so, another elicitation question is presented, such as: "Here are some parts of a W: X, Y, Z. What is a more general term for some of these?" The user may skip the question. If an answer is provided, it is treated in the same way that new entries ordinarily are handled.

The subroutine to establish a new node's position in the tree structure is the longest in the program (lines 1860-2710). First it clears some short-term memory for storing yes-no answers. Next it determines which existing nodes are superordinate to the new node. Then, working among the subordinates of these superordinates, it searches for existing nodes that are subordinate to the new node. The edge list is modified to reflect the new node's position.

An error-correction subroutine (lines 3680-4570) allows two kinds of changes to be made in the data. An entry in the name list can be changed to a different spelling (lines 3800-3850). Or a node can be deleted entirely from the graph (lines 3870-4570). In the latter case, the program checks whether subordinates are also to be deleted and, if so, deletes them first using the subroutine recursively. Recursion is achieved by defining a push-down 'stack' containing the nodes to be deleted, and letting the procedure work until the stack is empty. Deletion involves removing edges from the edge list and changing other edges in order to close up the graph over the deleted node. Deletion also involves removing the node from the name list and adjusting index numbers.

Output

A subroutine to display the matrix representation of the tree (lines 3130-3660) writes to screen or to printer. The lower triangle of the matrix is presented. Entry names, truncated to 13 characters, are listed in topological

Exhibit 2: Commands

| | |
|-------------|--|
| \$ | Skip to next question without answering this one. |
| # | Look at the chart. |
| #H | Print the chart on paper (requires a printer hooked up to the computer). |
| INAME | Change an entry that was entered as NAME. The program will instruct you on how to change the name, or delete the entry entirely. |
| @ | Analyze commonalities of two or more entries. The program will tell you what more general term covers all of the chosen entries, and in what way each chosen entry is a special case of the more general term. |
| " FILE NAME | Save all of the data on tape so that they can be read in again later. |
| ' FILE NAME | Save all data on disk. |
| T | As an answer to program's first question, this causes the program to read data from tape. |
| D | As an answer to program's first question, this causes the program to read data from disk. |

Exhibit 3: Sample Run

This program allows you to analyze the organization of:

1. people at a scene
2. actions in an event
3. the parts of an entity

Which analysis do you want to do? 1

What's a word naming the scene you're going to analyze? FAMILY

What's one kind of actor you might find at a family scene? FATHER

Who is an actor at a family scene — aside from a father? MOTHER

Is a mother always a father? N

Is a father always a mother? N

Answer \$ to skip.

What else might a father be at a family scene? HUSBAND

Exhibit 3 (continued)

Is a husband always a father? N
Is a husband always a mother? N
Is a father always a husband? Y
Is a mother always a husband? N
The final results of this analysis might look as follows when the matrix representation is printed.

AT A FAMILY SCENE

| | |
|----------|--------------|
| ADULT | X< |
| CHILD | X+< |
| MALE | X++< |
| FEMALE | X+++< |
| HUSBAND | +X+X+< |
| WIFE | +X++X+< |
| SON | ++X X+++< |
| DAUGHTER | ++X+X+++< |
| FATHER | ++++X+++< |
| MOTHER | +++++X+++< |
| BROTHER | ++++++X+++< |
| SISTER | +++++++X+++< |

Exhibit 4: Sample Printout

WHILE DINING OUT

| | |
|---------------|-----------------|
| LEAVING RESTA | X< |
| PAYING BILL | +X< |
| LEAVING TABLE | ++X< |
| LEAVING TIP | +++X< |
| WAITING FOR B | ++++X< |
| EATING FOOD | +++++X< |
| GETTING FOOD | ++++++X< |
| SITTING AT TA | +++++++X< |
| WAITING FOR F | +++++++X+< |
| GIVING ORDER | +++++++X++< |
| READING MENU | +++++++X+++< |
| WAITING FOR M | +++++++X++++< |
| FINDING TABLE | +++++++X+++++< |
| ENTERING REST | +++++++X++++++< |

WHILE DINING OUT

LEAVING RESTAURANT
PAYING BILL
LEAVING TABLE
LEAVING TIP
WAITING FOR BILL
EATING FOOD
GETTING FOOD
SITTING AT TABLE
WAITING FOR FOOD
GIVING ORDER
READING MENU
WAITING FOR MENU
FINDING TABLE
ENTERING RESTAURANT

PET FEATURE

order along the lefthand border (the full names are listed separately at the bottom when a hard copy is printed). Cells with zeros are left blank; cells with ones are marked graphically. Screen displays are limited to trees with less than 23 nodes; printed output covers the maximum size tree that the program handles — 63 nodes. The screen display is invoked randomly about one-third of the time after new entries are made (line 1830).

Common superordinates of two or more entries are found by another subroutine (lines 5070-5600). This procedure also indicates the immediate subordinates of the common superordinate. These subordinates lead down to each of the originally specified nodes — an analysis not easily done by inspection of the matrix. The algorithm involves concatenating all the up-graphs of the focus nodes, creating a dummy subordinate node of the focus nodes, and subtracting the up-graph of the dummy from the concatenated graphs (repeatedly if there are more than two focus nodes). The topologically lowest node of the remainder represents a commonality of the focus nodes. A search is made to find the immediate subordinates of the common

node that are linked to focus nodes. When multiple common nodes exist, they all are presented in turn. The dummy node is deleted before the subroutine ends.

The routine to save a knowledge base on tape or disk (lines 4590-4810) creates a file name from the label given as part of the save command, plus the name of the top node in the graph, as follows: LABEL.NODE1. The file contains the type of analysis as specified for the program's first question, the number of nodes, the node names, the number of edges, and the list of edges. The file can be read later by another routine (lines 4830-5050), called by typing T or D in answer to the first program question (data are listed as they are read into the program). Writing and reading are done with tape unit #1 or disk unit #0. A disk must be properly initialized before the program is run.

Utilities

Articles are appended to the front of entries for readability (lines 1330-1410). This routine inserts a nonprinting character with 'a' to make the appendage uniform in length, simplifying removal whenever necessary. Articles are not

added to event entries (option 2 in the program).

A subroutine (lines 800-860) presents the frequent query about relationships (e.g., "Is an X always a Y?"). The routine gets the answer and returns. A separate routine (lines 3030-3110) is used to add a name to the name list.

Loader Program

A separate loading program is shown in listing 2. This should be saved as the first program on a tape or disk. When it is loaded and RUN, it automatically loads the assembly language subroutines, guards the memory allocated to them, and then loads the main BASIC program and starts it running. On tape, the programs must be saved in the following order: loader (named anything); the file of assembly language subroutines, named CODE; main BASIC program, named TREES. These same file names must be implemented in order to use the loader program with a disk.

Entering the BASIC Code

A Glossary of special symbols used in the program listings is given at the
(Continued on page 74)

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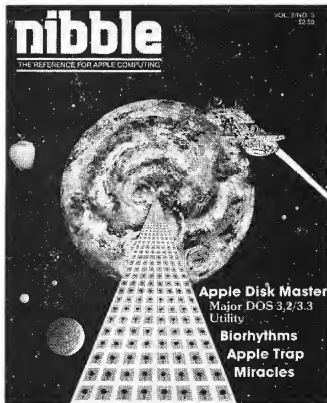
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(Continued from page 72)

end of the main program (lines 5620-5700).

REMARKS must be ignored when entering the main BASIC program into a 16K PET because all of the lines in listing 1 take up 18K. REMARKS could be included when using a 32K PET, but then the assembly language subroutine would have to be relocated.

6502 Assembly-Language Routine

A number of analytic functions are coded in 6502 assembly language for the sake of speed. The code is presented in listing 3, which begins with definitions of zero-page cells and the ROM subroutines used. These locations refer to Operating System 3.0 on the PET. Notes are included, where appropriate, for conversion to O.S. 1.0 and 4.0.

The short routine at lines 370-460 (called before the BASIC program is loaded) points the USR function to the code and protects the code from BASIC. The overall logic of the procedure can be seen in the executive program (lines 510-560).

A number of parameters have to be established every time the routine is called (lines 610-1630). The number of nodes is determined by finding the name list and counting the number of entries in it. The routine looks for a specific array, so the name list *must* be NM\$(). Next the routine finds the location and the length of the edge list, which *must* be named L\$(0). The name list and the edge list — and later two graphs named GR\$(0) and BR\$(0) — are found using a separate subroutine (lines 1100-1630). If an array is not found, a pointer is set to the word "array" among the PET's canned messages, and control is transferred to the standard error routine in ROM.

Three parameters are passed from BASIC when the USR function is invoked: the starting node from which to begin tracing a subgraph, a code indicating whether to trace upwards (0) or downwards (2), and a code indicating whether the list of encountered nodes should (1) or should not (0) contain the same element if the trace goes through it repeatedly. The no-repeat option usually is used in this application. The three numbers are combined into a single argument for USR; the starting node is added to the two code values, each multiplied by 256. The USR function transfers this number to FACC — the BASIC accumulator — in five-byte floating point format. After the number

has been converted to two-byte integer format (using the ROM routine, FLPINT), the parameters are recovered. The low byte of the argument equals the specified starting node. The high byte of the argument is ANDed with one to recover the Repeat code. The low byte is ANDed with two to recover the Up-Down code.

Lines 1670-2280 create a topological list of node index numbers, using the second tape cassette buffer as a work space. The list is not returned directly; it is used to order nodes encountered while tracing a subgraph. The procedure follows an algorithm presented by Gotlieb and Gotlieb (1978). If a loop is encountered in the graph, then the routine aborts and prints "complex error."

The routine in lines 2330-3050 makes a list of all the nodes in a graph that are reachable, either in an upward direction or a downward direction, from the specified starting node. The index numbers are converted to characters and stored in a string named GR\$(0), which must be dimensioned in the BASIC program. The length of GR\$(0) is returned as the value of the USR function.

The GR\$(0) list is put into topological order by lines 3090-3350. If the starting node is specified as one, with direction down, then GR\$(0) will return with a topological listing of all nodes in the graph.

The final part of the procedure, lines 3390-3760, removes elements in the GR\$(0) list from another list of elements, BR\$(0). This array must be dimensioned in the BASIC program. If none of the members of GR\$(0) is in BR\$(0), then BR\$(0) remains unchanged. If elements of GR\$(0) are in BR\$(0), then they are removed, making BR\$(0) shorter. BR\$(0) must always be defined with a space following it (e.g., see line 2070 of the BASIC program).

Every USR call performs all of these functions, even if some of them are not used.

Entering the Code

The procedure has been assembled for placement at the top of RAM in a 16K computer, and the same positioning can be used with a 32K machine. The positioning can be changed to the top of 32K RAM by changing every hex memory address in the \$3000 range so that it begins with seven instead of three. Enter the code with the CBM monitor, display the relevant cells with the M command, and overwrite the contents following listing 3. Use the following monitor command to save to disk.

```
.S "0:CODE",08,3DA8,3FF0
```

Use the following command to save on tape.

```
.S "CODE",01,3DA8,3FF0
```

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David Heise is Professor of Sociology at Indiana University. He recently edited "Microcomputers in Social Research" (Sage Publications, 1981). His books include *Causal Analysis and Understanding Events*. He has created commercial microcomputer programs for word processing and statistical analysis, and he has published a number of programs for PET computers. Contact Mr. Heise at the Department of Sociology, Indiana University, Bloomington, IN 47405.

Listing 2: Loader Program

```
100 : REM: LOADER PROGRAM
110 :
120 : REM: ROUTINE TO LOAD THE ASSEMBLED CODE, THEN THE MAIN PROGRAM.
130 : DV$="":CU$=""
140 : REM DV$="":CU$="CU$+" : REM ADD THIS LINE TO LOAD FROM TAPE.
150 : REM: SET GRAPHICS MODE.
160 : POKE 59468,12
170 : REM: STORE 4 CARR. RETURNS IN INPUT BUFFER,
    (USE 525 AND 527-530 FOR 1.0)
180 : POKE 158,4:POKE 623,13:POKE 624,13:POKE 625,13:POKE 626,13
190 : REM: SET UP SCREEN TO INVOKE THE SUBROUTINE FILE -- 'CODE'
200 : PRINT "LOAD" CHR$(34) "CODE" CHR$(34):DV$=PRINTCU$:"SYS 15784"
210 : REM: THEN LOAD PROGRAM 'MAIN'.
220 : PRINT "LOAD" CHR$(34) "MAIN" CHR$(34):DV$
230 : PRINT CU$ "RUN":END
```

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Tree Analysis (Continued)

```

1470 PRINT
1480 : REM: USE A SPECIAL QUESTION IF USING THE TOP NODE FOR ELICITATION.
1490 IF IP=1 THEN PRINT W$NM$(1):GOTO 1540
1500 : REM: OTHERWISE PRINT THE STANDARD STEM
1510 PRINT "WHAT ELSE MIGHT
1520 PRINT RIGHT$(NM$(IP),LEN(NM$(IP))-1)W$NM$(1)
1530 : REM: SHOWING PRESENT LINKS, IF ANY.
1540 IO=LEN(L$(0)):FOR I=1 TO IO STEP 2
1550 IF FNLI(I)=IP OR (FNLI(I+1)=IP AND FNLI(I)<>1) THEN I=IO+1:GOTO 1570
1560 NEXT I:GOTO 1640
1570 PRINT "----ASIDE FROM
1580 BR$(0)="":DI=2:LL=USR(IP+DOWN)
1590 FOR J=1 TO LL
1600 IF FNGB(J)>1 AND FNGB(J)<>IP THEN PRINT " NM$(FNGB(J))
1610 NEXT J
1620 IF DI THEN DI=0:LL=USR(IP+UP):GOTO 1590
1630 : REM: GET USER'S INPUT.
1640 GOSUB 670:AS=LEFT$(WD$,1)
1650 : REM: ALLOW SKIPPING.
1660 IF AS=" " THEN RETURN
1670 : REM: ACCEPT A PRINT-GRID COMMAND.
1680 IF AS="P" THEN GOSUB 3160:GOTO 1450
1690 : REM: ACCEPT REVERSE COMMAND.
1700 IF AS="R" THEN GOSUB 3700:GOTO 1450
1710 : REM: ACCEPT SAVE COMMAND.
1720 IF AS="S" OR AS="V" THEN GOSUB 4620:GOTO 1450
1730 : REM: ACCEPT ANALYZE COMMAND.
1740 IF AS="A" THEN GOSUB 5090:GOTO 1450
1750 : REM: THIS IS AN ENTRY!
1760 : REM: ADD AN ARTICLE TO THE WORD.
1770 GOSUB 1340
1780 : REM: ADD THE NODE TO NM$.
1790 H=LL:GOSUB 3060:IF H=LL THEN PRINT "<R>ALREADY EXISTS":GOTO 1450
1800 : REM: FIND THE NODE'S LINKAGES.
1810 GOSUB 1880
1820 : REM: GIVE AUTOMATIC PRESENTATION OF THE GRID OCCASIONALLY.
1830 IF RND(1)<.3 THEN WD$="*":GOSUB 3160
1840 RETURN
1850 :
1860 : REM: SUBROUTINE TO POSITION NEW NODE IN TREE.
1870 : REM: CLEAR SPACE FOR REMEMBERING YES-NO ANSWERS.
1880 FOR I=1 TO 65:ODX(I)=0:NEXT I
1890 : REM: GET A DOWN GRAPH FROM THE ORIGIN, WITHOUT REPEATS.
1900 BR$(0)="":LO=USR(1+DOWN)
1910 : REM: IS NEW NODE SUBORDINATE TO AN EXISTING NODE?
1920 FOR IB=1 TO LO
1930 : REM: STOP IF BEYOND THE LENGTH OF CURRENT GR$.
1940 IF IB>LEN(GR$(0)) THEN IB=LO:GOTO 2140
1950 : REM: AND SKIP THE QUESTION FOR THE ORIGIN.
1960 IF FNGB(IB)=1 THEN NEXT IB
1970 : REM: IF QUESTION WAS ASKED FOR THIS NODE, RECALL THE ANSWER.
1980 IF ODX(FNGB(IB))<>0 THEN AS=CHR$(ODX(FNGB(IB))):GOTO 2040
1990 : REM: OTHERWISE PRESENT QUESTION AND GET YES-NO ANSWER.
2000 W$NM$(ZZ):W2$=NM$(FNGB(IB)):GOSUB 810
2010 : REM: (REMEMBER THE ANSWER.)
2020 ODX(FNGB(IB))=ASC(AS)
2030 : REM: IF NEW NODE IS NOT SUBORDINATE TO A NODE,
2040 IF AS<>"N" THEN NEXT IB:GOTO 2140
2050 : REM: THEN REMOVE THAT NODE AND ITS SUBORDINATES FROM THE DOWN GRAPH.
2060 : REM: BY SETTING BR$(0) EQUAL TO A DUPLICATE OF GR$,
2070 BR$(0)=LEFT$(GR$(0))+", "LEN(GR$(0))
2080 : REM: REMOVING UNWANTED NODES FROM BR$,
2090 LL=USR(FNGB(IB)+DOWN)
2100 : REM: THEN SETTING GR$ EQUAL TO BR$.
2110 GR$(0)=LEFT$(BR$(0),LEN(BR$(0)))
2120 : REM: RELOOK AT THE REVISED GR$.
2130 IB=1
2140 NEXT IB
2150 : REM: CLEAR SPACE FOR REMEMBERING YES-NO ANSWERS.

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Tree Analysis (Continued)

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2160 FOR I=1 TO 65:ODX(I)=0:NEXT I
2170 : REM: CREATE A DUPLICATE OF THE CURRENT PRIMARY GRAPH.
2180 GR$=LEFT$(GR$(0),LEN(GR$(0)))
2190 : REM: WORK BACKWARD IN THE PRIMARY GRAPH UNTIL ALL NODES ARE DELETED.
2200 IB=LEN(GR$(0)):IF IB=0 THEN RETURN
2210 : REM: MAKE A LINK IN EDGE LIST FROM THIS NODE TO NEW NODE.
2220 L$(0)=L$(0)+RIGHT$(GR$(0),1)+CHR$(ZZ+64)
2230 : REM: GET THE DOWN-GRAPH FROM NODE IB.
2240 BI=FNGB(IB)
2250 BR$(0)="":LL=USR(BI+DOWN)
2260 : REM: LOOK AT NEXT NODE IN THE DOWN GRAPH,
2270 FOR BB=1 TO LL
2280 : REM: UNTIL ALL ARE CONSIDERED.
2290 IF BB>LEN(GR$(0)) THEN NEXT BB:GOTO 2690
2300 : REM: SKIP THE NEW NODE OR NODE IB.
2310 IF FNGB(BB)=ZZ OR FNGB(BB)=BI THEN NEXT BB:GOTO 2690
2320 : REM: IF QUESTION WAS ASKED FOR THIS NODE, RECALL ANSWER.
2330 K=ODX(FNGB(BB)):IF K<>0 THEN AS=CHR$(K):GOTO 2390
2340 : REM: OTHERWISE ASK IF THIS NODE IS SUBORDINATE TO THE NEW NODE.
2350 W$NM$(FNGB(BB)):W2$=NM$(ZZ):GOSUB 810
2360 : REM: (REMEMBER THE ANSWER.)
2370 ODX(FNGB(BB))=ASC(AS)
2380 : REM: WHEN THIS NODE, BB, IS SUBORDINATE TO NEW NODE, ZZ,
2390 IF AS="N" THEN NEXT BB:GOTO 2690
2400 : REM: SEE IF BB NODE IS DIRECTLY CONNECTED TO IB NODE.
2410 AS=LEFT$(GR$(0),1)+MID$(GR$(0),BB,1)
2420 FOR BC=1 TO LEN(L$(0)) STEP 2
2430 B$=MID$(L$(0),BC,2)
2440 : REM: IF IT IS NOT, THEN ADD EDGE FROM NEW NODE TO BB NODE
2450 IF AS=B$ THEN 2510
2460 NEXT BC
2470 : REM: (PROVIDING IT'S NOT ALREADY PRESENT.)
2480 IF K<>ASC("Y") THEN L$(0)=L$(0)+CHR$(ZZ+64)+MID$(GR$(0),BB,1)
2490 GOTO 2610
2500 : REM: IF IT IS, SUBSTITUTE EDGE ZZ-BB FOR OLD EDGE IB-BB
2510 C$=CHR$(ZZ+64)+MID$(L$(0),BC+1,1)
2520 : REM: (PROVIDING IT'S NOT ALREADY THERE.)
2530 FOR IO=1 TO LEN(L$(0)) STEP 2:IF MID$(L$(0),IO,2)=C$ THEN C$=""
2540 NEXT IO
2550 AS="":IF BC>1 THEN AS=LEFT$(L$(0),BC-1)
2560 B$="":IF BC<LEN(L$(0))-2 THEN B$=RIGHT$(L$(0),LEN(L$(0))-BC-1)
2570 : REM: (CLOSE THE BC LOOP.)
2580 BC=LEN(L$(0)):NEXT BC
2590 L$(0)=AS+C$+B$
2600 : REM: REMOVE BB AND ITS SUBORDINATE NODES FROM THE IB DOWN-GRAPH,
2610 BR$(0)=LEFT$(GR$(0),LEN(GR$(0)))
2620 LL=USR(FNGB(BB)+DOWN)
2630 GR$(0)=LEFT$(BR$(0),LEN(BR$(0)))
2640 : REM: AND RELOOK AT IT.
2650 BB=BB-1
2660 NEXT BB
2670 : REM: IF ALL SUBORDINATES OF IB ARE DONE, RETURN TO PRIMARY GRAPH.
2680 : REM: REMOVE NODES UPWARD FROM IB.
2690 BR$(0)=LEFT$(GR$+"",LEN(GR$)):LL=USR(BI+UP)
2700 : REM: AND CONTINUE.
2710 GR$(0)=LEFT$(BR$(0),LEN(BR$(0))):GOTO 2180
2720 :
2730 : REM: SUBROUTINE TO ELICIT GROUPING WORD.
2740 : REM: WHEN CURRENT NODE HAS 3+ IMMEDIATE SUBORDINATES,
2750 J=0:FOR I=1 TO LEN(L$(0)) STEP 2:IF CHR$(IP+64)=MID$(L$(0),I,1) THEN J=J+1
2760 NEXT I:IF J<3 THEN RETURN
2770 : REM: PRINT ELICITATION STIMULUS, ADJUSTING FOR KIND OF ANALYSIS.
2780 I=3:WIS$="":ON TA GOTO 2790,2810,2830
2790 PRINT:PRINT "HERE ARE KINDS OF ":IF IP=1 THEN WIS$="PARTICIPANTS":I=0
2800 GOTO 2840
2810 PRINT:PRINT "HERE ARE ASPECTS OF ":IF IP=1 THEN WIS$="WHAT HAPPENS":I=0
2820 GOTO 2840
2830 PRINT:PRINT "HERE ARE SOME PARTS":W1$=" OF ":IF IP=1 THEN W1$="OF":I=0

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Tree Analysis (Continued)

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2840 PRINT W$RIGHT$(NM$(IP),LEN(NM$(IP))-1),"
2850 : REM: PRINT IMMEDIATE SUBORDINATES OF NODE IP.
2860 FOR I=1 TO LEN(L$(0)):STEP 2
2870 IF CHR$(IP+64)=MID$(L$(0),I,1) THEN PRINT " NM$(FNL(I+1))
2880 NEXT I
2890 : REM: PRINT ELICITATION QUESTION AND GET ANSWER.
2900 PRINT:PRINT " WHAT IS A MORE GENERAL TERM FOR
2910 PRINT " SOME OF THESE (<R>=<R>: SKIP)":GOSUB 670
2920 : REM: PERMIT SKIP.
2930 IF WD$=" " THEN RETURN
2940 : REM: ACCEPT PRINT-GRID COMMAND.
2950 IF LEFT$(WD$,1)="#" THEN GOSUB 3160:GOTO 2750
2960 : REM: ADD AN ARTICLE TO NEW WORD, AND LINK IT INTO TREE.
2970 GOSUB 1340:H=L:GOSUB 3660:IF H=L THEN PRINT"<R>ALREADY EXISTS":GOTO2750
2980 GOSUB 1880
2990 : REM: SHOW GRID.
3000 GOSUB 3160
3010 RETURN
3020 : REM: SUBROUTINE TO ADD A WORD TO THE LIST OF WORDS, NM$.
3030 : REM: IF WORD ALREADY IS IN NM$
3040 : REM: THEN CLOSE LOOP AND RETURN.
3050 : REM:
3060 FOR JJ=2 TO IL
3070 IF WD$=LEFT$(NM$(JJ),LEN(WD$)) THEN ZZ=JJ:JJ=IL:NEXT JJ:RETURN
3080 NEXT JJ
3090 : REM: OTHERWISE ADD THE WORD TO NM$.
3100 ZZ=JJ:IL=JJ:NM$(JJ)=WD$
3110 RETURN
3120 :
3130 : REM: SUBROUTINE TO DISPLAY RESULTS ON GRID.
3140 : REM: ANSWER 'WH' GIVES HARD COPY.
3150 : REM: SET DEVICE # FOR SCREEN OR PRINTER.
3160 DV=3:IF MID$(WD$,2,1)="#" THEN DV=4
3170 : REM: SCREEN OUTPUT LIMITED TO 22 NODES.
3180 IF DV=3 AND IL>22 THEN RETURN
3190 : REM: IF ON THE 23RD NODE, PRINT ONE-TIME MESSAGE.
3200 MS$="TOO MANY ENTRIES TO DISPLAY GRID ON SCREEN.
3210 IF MS=0 AND IL>23 THEN PRINT MS:MS=1:RETURN
3220 : REM: SET GRAPHIC CHARACTERS FOR SCREEN OR PRINTER.
3230 LN$=CHR$(219):MK$=CHR$(209):DG$=CHR$(95)
3240 IF DV=4 THEN LN$="X":MK$="X":DG$="X"
3250 : REM: OPEN PRINTING FILE.
3260 OPEN I, DV
3270 : REM: CLEAR SCREEN AND PRINT HEADER.
3280 PRINT "<S>";
3290 PRINT#1,MID$(NM$(1),2):PRINT#1
3300 : REM: SEARCH DOWN TO GET ORDERED LIST OF NODES (GR$) WITHOUT REPEATS.
3310 BR$(0)="":LL=USR(X+DOWN)
3320 : REM: FOR EACH WORD IN TOPOLOGICAL ORDER,
3330 FOR IO=2 TO IL
3340 : REM: REMOVE ARTICLE,
3350 W1$=MID$(NM$(FNG(IO)),5)
3360 : REM: AND TRUNCATE IF TOO LONG.
3370 W1$=MID$(W1$,1,13)
3380 : REM: THEN PRINT ON NEXT ROW, FOLLOWED BY SPACES TO EDGE OF GRID.
3390 PRINT#1:PRINT#1,LEFT$(W1$+SP$,15);
3400 : REM: GENERATE GRID CHARACTERS.
3410 FOR JO=1 TO IO:ODZ(JO)=ASC(LN$):NEXT JO:ODZ(IO)=ASC(DG$)
3420 : REM: SET SPACING INDEX.
3430 JL=1
3440 : REM: GO THROUGH RECEIVER NODES IN EDGE-LIST TO FIND THIS NODE.
3450 FOR JO=2 TO LEN(L$(0)):STEP 2
3460 IF MID$(L$(0),JO,1)<MID$(GR$(0),IO,1) THEN NEXT JO:GOTO 3550
3470 : REM: NOW FIND SENDER-NODE'S TOPOLOGICAL ORDER,
3480 FOR JU=1 TO LL
3490 IF MID$(L$(0),JO-1,1)<MID$(GR$(0),JU,1) THEN NEXT JU
3500 : REM: INSERT A LINK MARK IN THE GRID LINE,
3510 ODZ(JU)=ASC(MK$)
3520 : REM: AND CLOSE LOOPS.

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Tree Analysis (Continued)

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3530 JJ=LL:NEXT JU,JO
3540 : REM: WHEN LINE IS FINISHED, PRINT IT.
3550 FOR JO=1 TO IO:PRINT#1,CHR$(ODZ(JO));:NEXT JO
3560 : REM: CONTINUE THROUGH ALL LINES.
3570 NEXT IO
3580 : REM: IF DOING HARD COPY, PRINT OUT NAMES.
3590 IF DV=4 THEN PRINT#1,FOR IO=1 TO IL:PRINT#1,NM$(FNG(IO)):NEXT IO
3600 : REM: CLOSE THE PRINT FILE, AND PRINT A MESSAGE.
3610 CLOSE 1
3620 PRINT"<S>".PRINT" <R>TYPE RETURN":PRINT" <R>TO CONTINUE
3630 : REM: WAIT FOR USER RESPONSE.
3640 GET A$:IF A$="" THEN 3640
3650 : REM: CLEAR SCREEN AND RETURN TO ELICITATION.
3660 PRINT "<S>":RETURN
3670 :
3680 : REM: SUBROUTINE TO REVISE A NODE.
3690 : REM: REMOVE : FROM FRONT OF WORD, ADD ARTICLE, AND FIND IN NM$ LIST.
3700 WD$=RIGHT$(WD$,LEN(WD$)-1):K=IL:GOSUB 1340:GOSUB 3060
3710 : REM: ABORT IF WORD WAS NOT IN NM$ LIST.
3720 IF K=IL THEN NM$(IL)="" :IL=IL-1:PRINT "<R>NOT FOUND":RETURN
3725 PRINT "<S>FOUND":PRINT "<R>NM$(ZZ)
3730 : REM: PRINT MENU.
3740 PRINT "YOU CAN <R>CHANGE THE NAME,
3750 PRINT " OR <R>DELETE THE WORD ENTIRELY,
3755 PRINT " OR <R>EXIT.
3760 PRINT "<D>ENTER <R>C<R>, <R>D<R>, OR <R>E<R>.
3770 GET A$:IF A$="" OR (A$="C" AND A$="E") THEN 3770
3780 : REM: GO TO SUBROUTINE FOR DELETION.
3785 IF A$="E" THEN RETURN
3790 IF A$="D" THEN GOSUB 3890:RETURN
3800 : REM: DO NAME CHANGE.
3810 PRINT "<D>NEW NAME FOR <R>RIGHT$(NM$(ZZ),LEN(NM$(ZZ))-3)
3820 PRINT "<R>";GOSUB 670
3830 : REM: ADD ARTICLE AND REPLACE.
3840 GOSUB 1340:NM$(ZZ)=WD$
3850 RETURN
3860 :
3870 : REM: SUBROUTINE TO DELETE A NODE.
3880 : REM: PUT NODE TO BE REMOVED ON 'STACK'.
3890 ODZ(0)=1:ODZ(1)=ZZ
3900 : REM: GET LAST NODE, X, ON STACK.
3910 X=ODZ(ODZ(0))
3920 : REM: DEFINE ITS DOWN-GRAPH,
3930 BR$(0)="":LL=USR(X+DOWN)
3940 : REM: WITHOUT THE X NODE.
3950 GR$(0)=RIGHT$(GR$(0),LO-1)
3960 : REM: SAVE GR$.
3970 GG$=LEFT$(GR$(0),LEN(GR$(0)))
3972 : REM: WHEN X HAS SUBORDINATES,
3974 IF LEN(GR$(0))=0 THEN 4270
3980 : REM: CONSIDER THE FIRST OF THEM.
3990 J=FNG(1)
4000 : REM: ASK IF NODE J IS TO BE KEPT.
4010 PRINT:PRINT "RETAIN <R>RIGHT$(NM$(J),LEN(NM$(J))-4)"<R>? ":GOSUB 830
4020 : REM: IF NOT, DELETE J RECURSIVELY. THEN START OVER ON X.
4030 IF A$="N" THEN ODZ(0)=ODZ(0)+1:ODZ(ODZ(0))=J:GOSUB 3910:GOTO 3910
4040 : REM: IF "YES", GET UP-GRAPH FROM J WITH REPEAT.
4043 BR$(0)=LL:USR(J+UP+256)
4044 : REM: DELETE EDGE FROM X TO J.
4050 A$=CHR$(X+64)+CHR$(J+64)
4060 K=LEN(L$(0))
4070 FOR I=1 TO K:STEP 2
4080 B$=MID$(L$(0),I,2)
4090 IF A$<B$ THEN NEXT I:GOTO 4210
4100 A$="":IF I>1 THEN A$=LEFT$(L$(0),I-1)
4110 B$="":IF I<K-1 THEN B$=RIGHT$(L$(0),K-I-1)
4120 L$(0)=A$+B$
4130 I=K:NEXT I
4140 : REM: AND USE UP-LINKS OF X TO DEFINE UP-LINKS OF J.

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Tree Analysis (Continued)

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2840 PRINT W$RIGHT$(NM$(IP),LEN(NM$(IP))-1),"
2850 : REM: PRINT IMMEDIATE SUBORDINATES OF NODE IP.
2860 FOR I=1 TO LEN(L$(0)):STEP 2
2870 IF CHR$(IP+64)=MID$(L$(0),I,1) THEN PRINT " NM$(FNL(I+1))
2880 NEXT I
2890 : REM: PRINT ELICITATION QUESTION AND GET ANSWER.
2900 PRINT:PRINT " WHAT IS A MORE GENERAL TERM FOR
2910 PRINT " SOME OF THESE (<R>=<R>: SKIP)":GOSUB 670
2920 : REM: PERMIT SKIP.
2930 IF WD$=" " THEN RETURN
2940 : REM: ACCEPT PRINT-GRID COMMAND.
2950 IF LEFT$(WD$,1)="#" THEN GOSUB 3160:GOTO 2750
2960 : REM: ADD AN ARTICLE TO NEW WORD, ENTER IN NM$, AND LINK IT INTO TREE.
2970 GOSUB 1340:H=L:GOSUB 3660:IF H=L THEN PRINT"<R>ALREADY EXISTS":GOTO2750
2980 GOSUB 1880
2990 : REM: SHOW GRID.
3000 GOSUB 3160
3010 RETURN
3020 : REM: SUBROUTINE TO ADD A WORD TO THE LIST OF WORDS, NM$.
3030 : REM: IF WORD ALREADY IS IN NM$
3040 : REM: THEN CLOSE LOOP AND RETURN.
3050 : REM:
3060 FOR JJ=2 TO IL
3070 IF WD$=LEFT$(NM$(JJ),LEN(WD$)) THEN ZZ=JJ:JJ=IL:NEXT JJ:RETURN
3080 NEXT JJ
3090 : REM: OTHERWISE ADD THE WORD TO NM$.
3100 ZZ=JJ:IL=JJ:NM$(JJ)=WD$
3110 RETURN
3120 :
3130 : REM: SUBROUTINE TO DISPLAY RESULTS ON GRID.
3140 : REM: ANSWER 'WH' GIVES HARD COPY.
3150 : REM: SET DEVICE # FOR SCREEN OR PRINTER.
3160 DV=3:IF MID$(WD$,2,1)="H" THEN DV=4
3170 : REM: SCREEN OUTPUT LIMITED TO 22 NODES.
3180 IF DV=3 AND IL>22 THEN RETURN
3190 : REM: IF ON THE 23RD NODE, PRINT ONE-TIME MESSAGE.
3200 MS$="TOO MANY ENTRIES TO DISPLAY GRID ON SCREEN.
3210 IF MS=0 AND IL>23 THEN PRINT MS:MS=1:RETURN
3220 : REM: SET GRAPHIC CHARACTERS FOR SCREEN OR PRINTER.
3230 LN$=CHR$(219):MK$=CHR$(209):DG$=CHR$(95)
3240 IF DV=4 THEN LN$="X":MK$="X":DG$="X"
3250 : REM: OPEN PRINTING FILE.
3260 OPEN 1,DV
3270 : REM: CLEAR SCREEN AND PRINT HEADER.
3280 PRINT "<S>";
3290 PRINT#1,MID$(NM$(1),2):PRINT#1
3300 : REM: SEARCH DOWN TO GET ORDERED LIST OF NODES (GR$) WITHOUT REPEATS.
3310 BR$(0)="":LL=USR(X+DOWN)
3320 : REM: FOR EACH WORD IN TOPOLOGICAL ORDER,
3330 FOR IO=2 TO IL
3340 : REM: REMOVE ARTICLE,
3350 W1$=MID$(NM$(FNG(IO)),5)
3360 : REM: AND TRUNCATE IF TOO LONG.
3370 W1$=MID$(W1$,1,13)
3380 : REM: THEN PRINT ON NEXT ROW, FOLLOWED BY SPACES TO EDGE OF GRID.
3390 PRINT#1:PRINT#1,LEFT$(W1$+SP$,15);
3400 : REM: GENERATE GRID CHARACTERS.
3410 FOR JO=1 TO IO:ODZ(JO)=ASC(LN$):NEXT JO:ODZ(IO)=ASC(DG$)
3420 : REM: SET SPACING INDEX.
3430 JL=1
3440 : REM: GO THROUGH RECEIVER NODES IN EDGE-LIST TO FIND THIS NODE.
3450 FOR JO=2 TO LEN(L$(0)):STEP 2
3460 IF MID$(L$(0),JO,1)<MID$(GR$(0),IO,1) THEN NEXT JO:GOTO 3550
3470 : REM: NOW FIND SENDER-NODE'S TOPOLOGICAL ORDER,
3480 FOR JU=1 TO LL
3490 IF MID$(L$(0),JO-1,1)<MID$(GR$(0),JU,1) THEN NEXT JJ
3500 : REM: INSERT A LINK MARK IN THE GRID LINE,
3510 ODZ(JJ)=ASC(MK$)
3520 : REM: AND CLOSE LOOPS.

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Tree Analysis (Continued)

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3530 JJ=LL:NEXT JJ,JO
3540 : REM: WHEN LINE IS FINISHED, PRINT IT.
3550 FOR JO=1 TO IO:PRINT#1,CHR$(ODZ(JO));:NEXT JO
3560 : REM: CONTINUE THROUGH ALL LINES.
3570 NEXT IO
3580 : REM: IF DOING HARD COPY, PRINT OUT NAMES.
3590 IF DV=4 THEN PRINT#1,FOR IO=1 TO IL:PRINT#1,NM$(FNG(IO)):NEXT IO
3600 : REM: CLOSE THE PRINT FILE, AND PRINT A MESSAGE.
3610 CLOSE 1
3620 PRINT"<S>".PRINT" <R>TYPE RETURN":PRINT" <R>TO CONTINUE
3630 : REM: WAIT FOR USER RESPONSE.
3640 GET A$:IF A$="" THEN 3640
3650 : REM: CLEAR SCREEN AND RETURN TO ELICITATION.
3660 PRINT "<S>":RETURN
3670 :
3680 : REM: SUBROUTINE TO REVISE A NODE.
3690 : REM: REMOVE : FROM FRONT OF WORD, ADD ARTICLE, AND FIND IN NM$ LIST.
3700 WD$=RIGHT$(WD$,LEN(WD$)-1):K=IL:GOSUB 1340:GOSUB 3060
3710 : REM: ABORT IF WORD WAS NOT IN NM$ LIST.
3720 IF K=IL THEN NM$(IL)="" :IL=IL-1:PRINT "<R>NOT FOUND":RETURN
3725 PRINT "<S>FOUND":PRINT "<R>NM$(ZZ)
3730 : REM: PRINT MENU.
3740 PRINT "YOU CAN <R>CHANGE THE NAME,
3750 PRINT " OR <R>DELETE THE WORD ENTIRELY,
3755 PRINT " OR <R>EXIT.
3760 PRINT "<D>ENTER <R>C<R>, <R>D<R>, OR <R>E<R>.
3770 GET A$:IF A$="" OR (A$="C" AND A$="E") THEN 3770
3780 : REM: GO TO SUBROUTINE FOR DELETION.
3785 IF A$="E" THEN RETURN
3790 IF A$="D" THEN GOSUB 3890:RETURN
3800 : REM: DO NAME CHANGE.
3810 PRINT "<D>NEW NAME FOR <R>RIGHT$(NM$(ZZ),LEN(NM$(ZZ))-3)
3820 PRINT "<R>":GOSUB 670
3830 : REM: ADD ARTICLE AND REPLACE.
3840 GOSUB 1340:NM$(ZZ)=WD$
3850 RETURN
3860 :
3870 : REM: SUBROUTINE TO DELETE A NODE.
3880 : REM: PUT NODE TO BE REMOVED ON 'STACK'.
3890 ODZ(0)=1:ODZ(1)=ZZ
3900 : REM: GET LAST NODE, X, ON STACK.
3910 X=ODZ(ODZ(0))
3920 : REM: DEFINE ITS DOWN-GRAPH,
3930 BR$(0)="":LL=USR(X+DOWN)
3940 : REM: WITHOUT THE X NODE.
3950 GR$(0)=RIGHT$(GR$(0),LO-1)
3960 : REM: SAVE GR$.
3970 GG$=LEFT$(GR$(0),LEN(GR$(0)))
3972 : REM: WHEN X HAS SUBORDINATES,
3974 IF LEN(GR$(0))=0 THEN 4270
3980 : REM: CONSIDER THE FIRST OF THEM.
3990 J=FNG(1)
4000 : REM: ASK IF NODE J IS TO BE KEPT.
4010 PRINT:PRINT "RETAIN <R>RIGHT$(NM$(J),LEN(NM$(J))-4)"<R>? ":GOSUB 830
4020 : REM: IF NOT, DELETE J RECURSIVELY. THEN START OVER ON X.
4030 IF A$="N" THEN ODZ(0)=ODZ(0)+1:ODZ(ODZ(0))=J:GOSUB 3910:GOTO 3910
4040 : REM: IF "YES", GET UP-GRAPH FROM J WITH REPEAT.
4043 BR$(0)=LL:USR(J+UP+256)
4044 : REM: DELETE EDGE FROM X TO J.
4050 A$=CHR$(X+64)+CHR$(J+64)
4060 K=LEN(L$(0))
4070 FOR I=1 TO K:STEP 2
4080 B$=MID$(L$(0),I,2)
4090 IF A$<B$ THEN NEXT I:GOTO 4210
4100 A$="":IF I>1 THEN A$=LEFT$(L$(0),I-1)
4110 B$="":IF I<K-1 THEN B$=RIGHT$(L$(0),K-I-1)
4120 L$(0)=A$+B$
4130 I=K:NEXT I
4140 : REM: AND USE UP-LINKS OF X TO DEFINE UP-LINKS OF J.

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Tree Analysis (continued)

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4150 K=K-2
4160 FOR I=2 TO K STEP 2
4170 IF MID$(L$(0),I,1)<>CHR$(X+64) THEN NEXT I:GOTO 4210
4171 : REM: (DON'T LINK IF PATH ALREADY EXISTS.)
4172 KK=0
4173 FOR II=1 TO LL
4174 IF MID$(L$(0),I-1,1)=MID$(GR$(0),II,1) THEN KK=KK+1
4175 NEXT II
4176 IF KK>1 THEN 4190
4180 L$(0)=L$(0)+MID$(L$(0),I-1,1)+CHR$(J+64)
4190 NEXT I
4200 : REM: TAKE DOWN-GRAPH OF J OUT OF GR$.
4210 BR$(0)=LEFT$(GR$(0),LEN(BR$(0)))
4220 LQ=USR(J+DOWN)
4230 GR$(0)=LEFT$(BR$(0),LEN(BR$(0)))
4240 : REM: AND CONTINUE WITH OTHER SUBORDINATES OF X.
4250 GOTO 3970
4260 : REM: WHEN X HAS NO SUBORDINATES, REMOVE ITS UP LINKS FROM L$.
4270 K=LEN(L$(0))
4280 FOR I=2 TO K STEP 2
4290 IF MID$(L$(0),I,1)<>CHR$(X+64) THEN NEXT I:GOTO 4350
4300 A$="": IF I>2 THEN A$=LEFT$(L$(0),I-2)
4310 B$="": IF I<K THEN B$=RIGHT$(L$(0),K-I)
4320 L$(0)=A$+B$
4330 I=K:NEXT I:GOTO 4270
4340 : REM: THEN REMOVE THE WORD FROM THE NM$ LIST.
4350 FOR I=X TO 64
4360 NM$(I)=NM$(I+1)
4370 NEXT I:NM$(65)=" "
4380 IL=IL-1
4390 : REM: LOOK THROUGH L$, AND
4400 FOR I=1 TO K
4410 : REM: IF AN INDEX VALUE IS ABOVE X,
4420 IF FN(I)<X THEN NEXT I:GOTO 4490
4430 : REM: DECREMENT IT TO ADJUST FOR THE DELETED NODE.
4440 A$="": IF I>1 THEN A$=LEFT$(L$(0),I-1)
4450 B$="": IF I<K THEN B$=RIGHT$(L$(0),K-I)
4460 L$(0)=A$+CHR$(ASC(MID$(L$(0),I,1))-1)+B$
4470 NEXT I
4480 : REM: SIMILARLY, ADJUST INDEX VALUES IN THE 'STACK'.
4490 FOR I=1 TO ODZ(0)
4500 IF ODZ(I)>X THEN ODZ(I)=ODZ(I)-1
4510 NEXT I
4520 : REM: REMOVE THE X NODE FROM THE 'STACK'.
4530 ODZ(0)=ODZ(0)-1
4540 : REM: WHEREUPON REMOVAL OF NODE X IS FINISHED.
4550 : REM: RESET SCANNING INDEX.
4560 IP=2
4570 RETURN
4580 :
4590 : REM: SUBROUTINE TO SAVE DATA.
4600 : REM: CALLED BY ENTERING .LABEL OR \LABEL AS A WORD.
4610 : REM: MAKE THE FILE NAME FROM NM$(1) AND THE LABEL.
4620 K=9-TA:IF TA=3 THEN K=4
4630 F$=MID$(WD$,2,7)+". "+MID$(NM$(1),K,8)
4640 : REM: SET UP TAPE SAVE.
4650 DV=1:CH=1
4660 : REM: BUT CHANGE TO DISK SAVE WHEN SLASH PRECEDES LABEL..
4670 IF LEFT$(WD$,1)="/" THEN DV=B:CH=5:F$="0:"F$+"S,W"
4680 : REM: OPEN THE WRITE FILE.
4690 OPEN 1,DV,CH,F$
4700 : REM: SAVE THE TYPE OF ANALYSIS (FOLLOWED BY 'RETURN'),
4710 PRINT#1,TA:CHR$(13);
4720 : REM: THE NUMBER OF NODES,
4730 PRINT#1,IL:CHR$(13);
4740 : REM: THE NODE NAMES,
4750 FOR I=1 TO IL:PRINT#1,CHR$(34):NM$(I):CHR$(34):CHR$(13);:NEXT I
4760 : REM: THE NUMBER OF EDGES,

```

```

4770 PRINT#1,LEN(L$(0))/2:CHR$(13);
4780 : REM: AND THE LIST OF EDGES.
4790 FOR I=1 TO LEN(L$(0)) STEP 2:PRINT#1,MID$(L$(0),I,2):CHR$(13);:NEXT I
4800 : REM: FINISH.
4810 CLOSE 1:RETURN
4820 :
4830 : REM: SUBROUTINE TO READ DATA,
4840 : REM: CALLED BY ENTERING T OR D AT FIRST QUESTION.
4850 : REM: GET THE FILE NAME.
4860 INPUT "<R>FILE NAME<P>:";F$
4870 : REM: SET UP TAPE READ,
4880 DV=1:CH=0
4890 : REM: BUT CHANGE TO DISK READ WHEN A$=D.
4900 IF WD$="D" THEN DV=B:CH=5:F$="0:"F$+"S,R"
4910 : REM: OPEN THE READ FILE.
4920 OPEN 1,DV,CH,F$
4930 : REM: GET AND DISPLAY THE TYPE OF ANALYSIS.
4940 INPUT#1,TA:PRINT "<Q><Q>TYPE OF ANALYSIS =";TA
4950 : REM: THE NUMBER OF NODES,
4960 INPUT#1,IL:PRINT IL:"NODES ARE:"
4970 : REM: THE NODE NAMES,
4980 FOR I=1 TO IL:INPUT#1,NM$(I):PRINT NM$(I);:NEXT I:PRINT
4990 : REM: THE NUMBER OF EDGES,
5000 INPUT#1,LL:PRINT LL:"EDGES:"
5010 : REM: AND THE LIST OF EDGES.
5020 FOR I=1 TO LL:INPUT#1,A$:PRINT A$;:L$(0)=L$(0)+A$:NEXT I:PRINT
5030 : REM: FINISH.
5040 CLOSE 1:ON TA GOSUB 900,1130,1280
5050 RETURN
5060 :
5070 : REM: SUBROUTINE TO DISPLAY COMMONALITIES.
5080 : REM: GET GENERAL DOWN-GRAPH.
5090 BR$(0)="":LL=USR(1+DOWN)
5100 : REM: SHOW NODES IN TYPOLOGICAL ORDER WITH REFERENCE NUMBERS.
5110 FOR I=2 TO IL:PRINT "<R>FN(I)("&<R>MID$(NM$(1),SP,5,15);:NEXT I
5120 : REM: PROMPT
5130 GG$="":K=1:ODZ(0)=0:PRINT:PRINT"COMMONALITIES FOR WHICH ENTRIES"
5140 INPUT "(ENTER 0 TO END)";ODZ(K):IF ODZ(K)=0 THEN 5210
5150 ODZ(0)=ODZ(0)+1
5160 : REM: CONCATENATE THE UP-GRAPHS.
5170 LL=USR(ODZ(K)+UP)
5180 GG$=GG$+BR$(0)
5190 K=K+1:GOTO 5140
5200 : REM: CREATE A DUMMY SUBORDINATE OF FOCUS NODES.
5210 IL=IL+1:NM$(IL)="QQ"
5220 FOR I=1 TO ODZ(0):L$(0)=L$(0)+CHR$(ODZ(I)+64)+CHR$(IL+64):NEXT I
5230 : REM: ELIMINATE IRRELEVANT NODES FROM GG$ BY TAKING UP-GRAPH FROM QQ.
5240 FOR I=1 TO ODZ(0)-1
5250 BR$(0)=LEFT$(GG$+" ",LEN(BR$(0)))
5260 GG$=LEFT$(BR$(0),LEN(BR$(0)))
5270 : REM: REPEAT IF MORE THAN TWO FOCUS NODES.
5280 NEXT I
5290 : REM: LOWEST NODE OF GG$ IS A COMMONALITY.
5300 K=ASC(RIGHT$(GG$,1))-64
5310 PRINT:PRINT "COMMONALITY="NM$(K)
5320 : REM: ELIMINATE ITS UP-GRAPH.
5330 BR$(0)=LEFT$(GG$+" ",LEN(BR$(0)))
5340 GG$=LEFT$(BR$(0),LEN(BR$(0)))
5350 : REM: FIND SUBORDINATES LEADING TO EACH FOCUS NODE.
5360 FOR J=1 TO ODZ(0)
5370 : REM: PRINT RELEVANT FOCAL NODE AND ITS SUBCOMMONALITIES.
5380 PRINT "FOR NM$(ODZ(J))
5390 : REM: GET UP-GRAPH FROM FOCUS NODE.
5400 BR$(0)="":LL=USR(ODZ(J)+UP):A$=LEFT$(BR$(0),LEN(BR$(0)))
5410 : REM: GET DOWN-GRAPH FROM COMMON NODE.
5420 LL=USR(K+DOWN):B$=LEFT$(BR$(0),LEN(BR$(0)))
5430 : REM: SUBTRACT DOWN-GRAPH FROM SUBORDINATE OF COMMON NODE:

```


[illegible]

Trees (continued)

```

3EF1- A9 00 2400 DI LDA #0 ;BUT IF SEARCHING DOWN,
3EF2- F0 06 2410 BEQ STOREY ;INSERT AN INY COMMAND,
3EF3- A9 C8 2420 STA CMD ;AND ADJUST Y.
3EF4- 80 0E 3F 2430 DEY ;
3EF5- 80 0E 3F 2440 STY *-1 ;START GRAPH WITH NODE
3EF6- 80 06 3F 2450 STOREY LDA #0 ;GIVEN AS STARTING POINT.
3EF7- A2 00 2460 LDA #0 ;STORE THE CURRENT NODE IN GR$.
3EF8- A9 00 2470 SP STA GRAPH,X ;INITIALIZE Y.
3EF9- 9D 7A 02 2480 BUILDGR LDY #0 ;IF CURRENT GR$ NODE = NEXT L$ NODE
3F00- A0 00 2490 I CMP (NAME),Y ;
3F01- D1 42 2500 BNE NEXTEDGE ;PUT NODE
3F02- D0 19 2510 PHA ;AND ITS L$ POSITION
3F03- 48 2520 TYA ;ON STACK.
3F04- 98 2530 PHA ;(DEY FOR UP SEARCH, INY FOR DOWN.)
3F05- 48 2540 DEY ;GET OTHER NODE IN EDGE.
3F06- 88 2550 CMP (NAME),Y ;
3F07- B1 42 2560 LDY #0 ;IF REPEATS ARE NOT WANTED
3F08- D0 19 2570 BNE PUTIN ;(TRANSFER X TO Y.)
3F09- 48 2580 PHA ;
3F10- 98 2590 PHA ;
3F11- A0 00 2600 BNE PUTIN ;
3F12- D0 0C 2610 TXA ;
3F13- 48 2620 PHA ;
3F14- 88 2630 TXA ;
3F15- 48 2640 PHA ;
3F16- 88 2650 TXA ;
3F17- A8 2660 PLA ;
3F18- 68 2670 CMP GRAPH,X ;AND NODE ALREADY IS IN GR$
3F19- D9 7A 02 2680 BEQ BACKUP ;THEN CONTINUE SEARCH.
3F20- F0 11 2690 DEY ;
3F21- 88 2700 BPL UNIQUE ;OTHERWISE MAKE IT THE
3F22- E8 2710 INX ;NEW CURRENT NODE IN GR$.
3F23- 10 DE 2720 BPL BUILDGR ;
3F24- C0 00 2730 CPY #0 ;
3F25- F0 07 2740 BEQ BACKUP ;
3F26- 88 2750 DEY ;
3F27- F0 04 2760 BEQ BACKUP ;
3F28- 88 2770 DEY ;
3F29- 4C 07 3F 2780 JMP SEARCHL ;CONTINUE SEARCHING L$, OR
3F30- 68 2790 PLA ;GET LAST ENTRIES ON STACK
3F31- 68 2800 PLA ;
3F32- 10 F0 2810 BPL NEXTEDGE ;AND CONTINUE THAT SEARCH.
3F33- E8 2820 INX ;
3F34- 8E 4D 3F 2830 STX GL+1 ;SEARCH IS DONE IF STACK IS EMPTY.
3F35- 88 2840 TXA ;STORE GR$ LENGTH FOR RECALL.
3F36- 8A 2850 TXA ;
3F37- A8 2860 TXA ;
3F38- A8 2870 TXA ;
3F39- A8 2880 TXA ;
3F40- A9 00 2890 LDA #0 ;
3F41- 20 6D D2 2900 JSR INTFLP ;
3F42- A9 47 2910 STA #NAME ;GET POINTER TO GR$ HEADER.
3F43- 85 42 2920 STA #NAME ;
3F44- A9 52 2930 ORA #128 ;
3F45- 09 80 2940 STA #NAME+1 ;
3F46- 85 43 2950 JSR FIND ;
3F47- 20 1D 3E 2960 GLD ;STORE LENGTH OF GR$
3F48- A9 00 2970 LDA #0 ;
3F49- A0 01 2980 LDY #1 ;
3F50- 91 54 2990 STA (LA, POINTER),Y ;
3F51- C8 2990 INY ;AND POSITION OF GR$.
3F52- C8 3000 LDA #L, GRAPH ;
3F53- A9 7A 3010 STA (LA, POINTER),Y ;
3F54- C8 3020 INY ;
3F55- C8 3030 LDA #H, GRAPH ;
3F56- A9 02 3040 STA (LA, POINTER),Y ;
3F57- 91 54 3050 RTS ;PUT GR$ IN TOPOLOGICAL ORDER.
3F58- 60 3060 ;
3F59- 60 3070 ;
3F60- 60 3080 ;

```

Trees (continued)

```

3F61- A0 00 3090 REORDER 3F62- B9 B3 03 3110 TORDER 3F63- A2 00 3120 INGR 3F64- DD 7A 02 3130 FINDANODE 3F65- 48 3140 PHA ; 3F66- 48 3150 STX J'GR+1 3F67- 8E 88 3F 3160 BEQ SHIFT 3F68- F0 09 3170 BNE DOWNSHIFT 3F69- CA 3180 LDA GRAPH,X 3F70- 7A 02 3190 STA GRAPH,X 3F71- 48 3200 INX ; 3F72- 7A 02 3210 STA GRAPH,X 3F73- 48 3220 DEY ; 3F74- CA 3230 CPX I'GR+1 3F75- 8E 66 3F 3240 BNE DOWNSHIFT 3F76- DD F2 3250 INC I'GR+1 3F77- 48 3260 PLA ; 3F78- 68 3270 STA GRAPH,X 3F79- 7A 02 3280 LDY #0 ;CONTINUE SEARCH TO END OF GR$. 3F80- A2 00 3290 NEXTGR INX ; 3F81- E8 3300 CPX GL+1 ;(LENGTH OF GR$) 3F82- DD 4D 3F 3310 BNE FINDANODE 3F83- 48 3320 INY ; 3F84- 68 3330 CPY LL+1 ;ADVANCE IN TLIST. 3F85- DD 0C 3340 BNE TORDER ;(# OF NODES) 3F86- 60 3350 RTS ; ***** 3F87- 68 3360 LDA #1B' ;REMOVE GR$ NODES FROM BR$ 3F88- 85 42 3370 STA #NAME ;FIND BR$. 3F89- A9 52 3410 LDA #128 ; 3F90- 09 80 3420 ORA #128 ; 3F91- 85 43 3430 STA #NAME+1 ; 3F92- 20 1D 3E 3440 JSR FIND ; 3F93- A8 4D 3F 3450 LDX GL+1 ;GET LENGTH OF GR$. 3F94- CA 3460 STA #L, STARTN ; 3F95- AC 8A 3E 3470 LDY LL+1 ;SET CURRENT LENGTH OF BR$ 3F96- C8 3480 INY ;AS LOOP LIMITER. 3F97- 8C D5 3F 3490 STY BR'END+1 ;SET INDEXES FOR REWINDING BR$. 3F98- A0 00 3500 LDA #0 ; 3F99- A0 00 3510 STY NEWBR+1 ; 3F100- 8C BA 3F 3520 STY OLDVBR+1 ; 3F101- 8C D3 3F 3530 CLV ; 3F102- B8 3540 LDA (NAME),Y ; 3F103- A0 00 3550 REWRITE ; 3F104- 91 42 3560 STA #NAME ; 3F105- 42 3570 BVS COPY ;AND REWRITE IT FOR NEW VERSION. 3F106- DD 7A 02 3580 CPX GRAPH,X ;IF CHARACTER IS NOT DELETED YET 3F107- C8 3590 BNE COPY ;AND IS SAME AS THE GR$ CHARACTER, 3F108- C8 3600 DEC LL+1 ;DECREMENT BR$ LENGTH 3F109- 2C E5 3E 3620 BIT TRACE+1 ;AND SET THE FLAG FOR COPYING. 3F110- 70 03 3630 BVS BUMPOLD ;OTHERWISE INCREMENT WRITE INDEX 3F111- E8 BA 3F 3640 INC NEWBR+1 ; 3F112- A0 00 3650 COPY ; 3F113- E8 D3 3F 3660 INC OLDVBR+1 ; 3F114- A0 00 3670 BUMPOLD ; 3F115- A0 00 3680 OLDVBR LDY #0 ; 3F116- C0 00 3690 BEND CPY #0 ;AND CONTINUE THROUGH BR$. 3F117- DD DF 3700 BNE REWRITE ; 3F118- E8 00 3710 CPX #0 ; 3F119- DD CA 3720 BNE STARTN ;REPEAT FOR NEXT GR$ CHARACTER. 3F120- A0 01 3730 LDA LL+1 ;STORE FINAL LENGTH OF BR$ 3F121- 91 54 3740 STY (LA, POINTER),Y ;IN BR$ HEADER. 3F122- 60 3750 RTS ;STA (LA, POINTER),Y

```

MICRO



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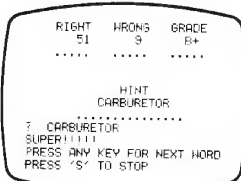
CAI Programs Vol I

Cassette CS-4201 \$11.95

Requires 16K Apple II or Apple II Plus



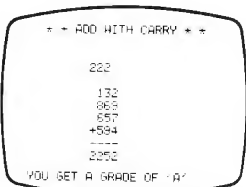
U.S. Map. Identify states and their capitals.



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TAG simulates the tagging and recovery method that is used by scientists to estimate animal populations. You attempt to estimate the bass population in a warm-water, bass-bluegill farm pond. Tagged fish are released in the pond and samples are recovered at timed intervals. By presenting a detailed simulation of real sampling by "tagging and recovery," TAG helps you to understand this process.

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Diet
DIET is designed to explore the effect of four basic substances, protein, lipids, calories and carbohydrates, on your diet. You enter a list of the types and amounts of food eaten in a typical day, as well as your age, weight, sex, health and a physical activity factor. DIET is particularly valuable in indicating how a diet can be changed to raise or lower body weights and provide proper nutrition.



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Disk CS-4701, \$24.95
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PET Menu and Tape Timer

by Dale De Priest

This article describes a menu program that allows rapid access to any program on either side of a cassette tape. In addition, a tape timer is presented that supplies the fast forward times for the menu program. These two programs feature advanced cassette control and use the WAIT command extensively.

MENU and TAPE TIMER
require:
PET
cassette

Every disk operating system has a way of maintaining a directory or menu on each disk. This directory allows you to find out the names of all the programs on the disk, and allows the disk operating system to locate these programs. A workable tape operating system should also provide a directory for its tapes.

The PET operating system is capable of locating and loading programs from tape but it is slow. We need some way to index the programs so that they can be located with the fast-forward mode. Unfortunately Commodore didn't provide for an index counter on their tape drive. So, I decided to develop a program to simulate an index counter and the directory or menu operation.

Menu Program

My original goal in creating the menu program was to provide a loader that would allow you to access any portion of the tape in as much time as it would take to get to the second program on a conventional tape. Since an average program takes about 90 seconds to load, I needed a program that would load in 30 seconds, thereby allowing 60 seconds for the fast-forward time.

Listing 1

```
50 REM DOCUMENTED SAMPLE MENU PROGRAM
52 REM WRITTEN BY DALE DE PRIEST
54 :
56 :
58 REM VARIABLE USAGE
60 REM A = INPUT NUMERIC VALUE
62 REM B = LOCATION OF INPUT BUFFER
64 REM C = CASSETTE #1 SWITCH FLAG
66 REM D = ADDRESS POINTING TO NUMBER OF CHARACTERS IN INPUT BUFFER
68 REM F = NUMBER OF PROGRAMS ON THIS ENTIRE TAPE
70 REM G = THE NUMBER OF THE FIRST PROGRAM ON THE OTHER SIDE
72 REM J = VARIABLE FOR 'FOR' LOOP
74 REM T1 = TIME AT THE BEGINNING OF THE SEARCH
76 REM A$ = INPUT VARIABLE
78 REM B$ = A MESSAGE
80 REM C$ = THE LOAD/RUN COMMAND STRING
82 REM A$(F) = NAMES OF ALL THE PROGRAMS ON THIS TAPE
84 REM A$(F) = FAST FORWARD SEARCH TIMES FOR EACH PROGRAM
86 :           IN TENTHS OF SECONDS
88 :
90 REM INITIALIZE AND RANDOMIZE THE RANDOM NUMBER GENERATOR
100 F=36:G=20:A=RND(-T1):PRINT"MENU":DIMA$(F),A$(F)
106 :
108 REM CORRECTS ADDRESSES FOR OLD AND NEW ROMS
110 B=527:C=519:D=525:IFPEEK(5E4)THEND=158:B=623:C=249
116 :
118 REM PRINT THE NAMES OF ALL THE PROGRAMS AND THE SELECTION NUMBER
120 FORJ=1TOF:IFJ=21THENPRINT"END"
122 READA$(J):READA$(J):IFJ>20THENPRINTTAB(20);
124 PRINTJ:A$(J):NEXT:IFF>20THENFORJ=FTO39:PRINT:NEXT
126 PRINT"ENTER THE NUMBER BESIDE THEN"
128 :
130 REM THE 4 BLANKS AFTER 'WISH' ARE SHIFTED BLANKS
132 INPUT"PROGRAM YOU WISH   ";A$:A$=VAL(A$):IFAC(10R)>FTHEN160
134 IFA(C)<>1THEN200
136 :
138 REM THIS SIMULATES THE RUN/STOP KEY
140 C$="LOAD"+CHR$(13)+"RUN"+CHR$(13):FORJ=0TO8:POKEB+J,ASC(MID$(C$,J+1))
142 NEXT:POKEB,J:END
144 :
146 B$="PLEASE PRESS STOP ON THE CASSETTE":PRINTB$:WAIT59408.16
148 :
150 REM THE OPERATING SYSTEM AUTOMATICALLY GIVES MOTOR CONTROL TO THE USER
152 PRINT"PRESS THE FAST FWD BUTTON":WAIT59408.16.16
154 :
156 REM THE POKE RETURNS MOTOR CONTROL BACK TO THE COMPUTER
158 PRINT"LOOKING FOR "A$(A):POKEC,52:T1=T1
160 IFT1-T1<A$(A)*6THEN240
162 :
164 REM THE COMPUTER ACTUALLY STOPS THE TAPE MOTION
166 POKE59411.61:PRINT"END":MID$(B$,9):WAIT59408.16:IFAC(10R)THEN180
168 PRINT"TURN THE CASSETTE OVER":FORJ=1TO3000:NEXTJ:GOTO180
170 :
172 REM SAMPLE NAMES AND SEARCH TIMES
174 DATA COVER16,1,NAB!,52,FIRE!,133,ALIENS!,195,BONZO!,246,CATCH!,309
176 DATA COVER17,349,POLICE!,393,SPOT,460,RULER,507,LETTER,539,MERGE,594
178 DATA PACK,630,COVER18,661,DROMEDA!,691,JOUST,750,WEATHER,797
180 DATA HI RES,856,SHEEP,900
182 :
184 REM THESE PROGRAMS ARE ON THE BACK SIDE OF THE TAPE
186 DATA COVER19,938,FROG!,896,GODZILLA!,847,MINER!,795,RAIL,746,GBOOKA,703
188 DATA BOOKB,663,COVER20,617,MUSIC!,584,BETS,528,CHECKERS,470
190 DATA CURVES,420,EQUIP,375,COVER21!,304,CAPTURE!,239,DANCE!,178,
192 BOSWAIN,93
194 :
196 REM THIS LINE IS NOT USED BY THE PROGRAM BUT PROVIDES DATA
198 FOR THE USER IF
200 REM YOU WISH TO ADD AN ADDITIONAL PROGRAM TO THIS TAPE
202 DATA END OF TAPE,948,1790
```

Listing 1 shows the result of this effort. It allows for up to 40 programs to be located on the same tape and will find any one of 30 programs in approximately 60 seconds. This program should be the first program on each of your cassettes, but it could be on a separate tape and contain the menu for several tapes. This would be desirable for tapes such as Cursor Magazine. Several interesting things can be learned from this program, so let me show you how it works.

Line 100: The statement `A=RND (-TI)` doesn't have anything to do with the rest of the program. It is simply an easy way to insure that the RND function is randomized for every program on the tape.

Line 110: The variable C points to the location of a flag that the PET uses to determine whether it or the user has control of the cassette motor. When you push one of the switches down, the PET turns on the motor for you. Since it believes that the operator should have control, it won't let the program stop the drive unless variable C is changed. A zero in this location means that the operator has control; any other value gives control to the PET.

Line 170: By convention the first program after the menu will contain a fast-forward value of one. This means no fast-forward is required.

Line 180-190: This is a special trick on the PET. This line stores the two commands LOAD and RUN in the PET's input buffer. You may wonder why the simpler method of

```
180 POKE B, 131:POKE D,1: END
```

is not used. This line forces the PET to respond as if the operator just hit the RUN/STOP key. The PET will load and run the next program. Unfortunately BASIC 4.0 directs this command to the disk, so you must put the command in the buffer yourself to make this program work with all versions of PET software. This technique is frequently useful when one program wants to turn control over to another program.

Line 200: This is the mysterious WAIT command. Here it is used to detect whether or not a key has been pressed. 59408 is the address whose contents will change and 16 is the decimal equivalent for the bit (bit 4) which will change to a 1 when the key is pressed. (If the bit were changing from 1 to 0, then the command would be WAIT 59408,16,16.)

Line 500-540: These lines contain the DATA statements that define the program names and the search times. The names recorded here do not need to be exactly the same as the name the program is stored under. They are only used by this program and not by the actual load routine. When setting up a tape for the first time you may not yet know the names of the programs that you are going to put on that tape. Be sure that you add enough filler to allow room to add these names later. I usually copy the menu from a different tape and then change the names as I need to. Setting F in line 100 will avoid confusion of the real contents of tape and the data that may be present simply to take up space. As each program is added I go back and update the menu program. This is easy since the long leaders prevent wiping out the second program.

This program works fine, but there is no way to easily determine what the fast-forward times should be. Now look at listing 2.

Tape Timer

This program supplies the fast-forward times for the menu program. In addition, it will provide a listing of your tape along with the load times for each program. The significant details are outlined below.

Line 120: This line finds headers and then measures the length of time between them. You should notice that although a program LOAD can distinguish between programs and data, an OPEN cannot. The last statement on the line initializes the program name variable.

Line 130: This line shows a method of getting the name of a program or data header into the program. The technique is to build a string right from the header buffer area. This is a useful line of code and shows you how to read beyond the sixteenth character of the header.

Line 150: H is the variable that is used to accumulate the time for all programs. Fast forward on a cassette tape is not linear. That is, there is no direct correlation between fast-forward times and normal play times. Although there is probably a mathematical formula that could be developed to calculate this relationship, the program uses a group of straight lines to approximate the curve. It then calculates a proportional relationship between these values. Empirically I have determined that the relationship between H and M for the first 200 seconds is .78.

Therefore if a load time of 100 seconds were measured, then this program would calculate the fast-forward time to be 7.8 seconds. All fast-forward times are calculated in tenths of seconds.

Lines 160-210: These lines continue the straight line approximations to the curve. Each value has been determined empirically to stop the tape 10 to 15 seconds in front of a header. This program should be fairly accurate for cassettes up to 60 minutes long. Longer cassettes use thinner tape which will invalidate the times.

Line 230: This line assumes that the menu program was stored with the name MENU as the first four characters. This is a convention that I always follow. Checking for this name allows the program to recalibrate itself to do all timings just after the menu load. The program will also work correctly when your program menu is on a different tape since the time is then from the beginning of tape.

Line 250: This program assumes that tapes have been properly ended with an end-of-tape header. The search times may then be copied to enter into the menu program. This program uses a feature of the cassette unit that causes it to shut off automatically when it reaches the end of a tape. When this happens, the program calculates the actual length of the tape. If you were to fast-forward the tape from the other end, it would then compute the fast-forward times. These times should be entered on a MENU program located at the beginning of the back side of the tape.

Putting It All Together

Now that you have seen the two programs, let's see how we can put them to work. First, you must build your tape by putting a MENU on the front of the tape followed by several programs. The tape must end with a file named "END OF TAPE." The easiest way is to type the following command in immediate mode.

```
OPEN1,1,2,"END OF TAPE":CLOSE1
```

Then load the TAPE TIMER program and time the tape. Write the front side search times as well as the names on a piece of paper. Hit the space bar and record the reverse side search times. Load in a copy of the MENU program and modify it with the correct names and reverse search times. Set the values of F and G to the correct values. Store

PET FEATURE

this new program as the first program on the back side.

Next, fast-forward the tape to the beginning of side one. Change the search times to the correct ones for the front side. Change variable G, and save this new update over the top of the old MENU program. You now have a complete tape that can be searched from either direction. Of course you could also add programs to the back of the tape.

To use this program, rewind the tape to either end. Then simply use the SHIFT/RUN keys to get the MENU program in and running. (This will not work for BASIC 4.0 users.) The MENU program will then do the rest. This way, someone who is not familiar with programming will be able to use your tapes.

Manual Updating

There will be times when you want to add a program to the end of a tape. Simply position your tape just past the current last program, either by loading or verifying it, and then save your program. Be sure to add a new "END OF

TAPE" header. You could then load in the tape timer and retape your tape. Then go back and update your MENUS. There is an easier way. It takes a little bit of advance planning but it works like a charm.

When the tape timer program finds the end of tape it outputs two things

about that point: the fast-forward search time and the total load time. When you create your menu program for that tape you should add these two numbers to the program. They can be added as additional data statements that are never read or they can be added in a remark. Now when you wish to add a program you will be ready.

Listing 2

```

10 REM TAPE TIMER
12 REM WRITTEN BY DALE DE PRIEST
14 :
16 :
18 REM VARIABLE USAGE
20 REM C = CASSETTE #1 SWITCH FLAG
22 REM H = ACCUMULATED TOTAL LOAD TIME
24 REM I = VARIABLE FOR 'FOR' LOOP
26 REM J = COUNTER FOR NUMBER OF PROGRAMS
28 REM M = COMPUTED SEARCH TIME
30 REM T1 = INITIAL TIME OF TIMER
32 REM A$(24) = NAMES OF EACH OF THE PROGRAMS
34 REM A(24) = LOAD TIMES FOR EACH OF THE PROGRAMS
36 REM LR = LENGTH OF RECORD IN BYTES
38 :
40 :
50 PRINT "PLEASE INSERT AND START THE TAPE YOU":PRINTTAB(15)
60 PRINT "HIGH TO TIME IN TAPE # 1"
62 :
68 REM DEFINE FUNCTION FOR ADDRESS PEEKING AND CORRECT FOR OLD AND NEW ROMS
70 DEFNAD(C)=PEEK(C)+PEEK(C+1)*256:C=519:IFPEEK(5E4)THENC=249
74 :
76 REM WAIT UNTIL TAPE STOP IS DEPRESSED THEN WAIT FOR THE PLAY BUTTON
78 REM THEN GIVE MOTOR CONTROL BACK TO THE COMPUTER
80 WAITS9408,16:WAITS9408,16,16:POKEC,52
90 DIMA(30),A$(30):A$(0)="BEGINNING OF TAPE"
100 PRINT "NAME SEARCH TIME LOAD TIME"
102 :
108 REM ALL TAPES MUST END WITH A FILE NAMED "END OF TAPE"
110 PRINTA$(J):INT(M):IFLEFT$(A$(J),11)="END OF TAPE"THEN250
114 REM INITIALIZE TIME & START THE TAPE MOVING
115 T1=TI:POKE59411,53
116 :
118 REM SPACE OVER THE PROGRAM FILE WITHOUT READING
120 IF T1-T1<LRGOTO120
122 :
124 REM OPEN WILL FIND BOTH PROGRAM AND DATA FILES
125 J=J+1:OPEN1,1:A(J)=(T1-T1)/60:A$(J)=" "
126 :
128 REM THIS LINE FINDS THE PROGRAM NAME FROM THE TAPE HEADER
130 FORI=639TO659:A$(J)=A$(J)+CHR$(PEEK(I)):NEXTI:CLOSE1:PRINTINT(A(J))
140 GOSUB150:LR=1:IFPEEK(634)=1THENLR=.0162*60*(FNAD(637)-FNAD(635))+200
145 GOTO110
146 :
148 REM THESE LINES ACTUALLY COMPUTE THE FAST FORWARD TIMES
150 M=H+A(J):M=IFM<200THENM=.78*M:GOTO230:REM <200
160 M=M-200:IFM<200THENM=153+.67*M:RETURN:REM 200-400
170 M=M-200:IFM<200THENM=285+.58*M:RETURN:REM 400-600
180 M=M-200:IFM<200THENM=401+.54*M:RETURN:REM 600-800
190 M=M-200:IFM<200THENM=507+.49*M:RETURN:REM 800-1000
200 M=M-200:IFM<300THENM=605+.46*M:RETURN:REM 1000-1200
210 M=M-300:M=740+.42*M:RETURN:REM >1200
230 IFLEFT$(A$(J-1),4)="MENU"THENM=0:M=1
240 RETURN
244 :
246 REM TURN THE MOTOR ON AND WAIT FOR THE AUTO SHUT OFF FEATURE
248 REM "H" NOW REPRESENTS THE TOTAL ACCUMULATED LOAD TIMES
250 T1=TI:POKE59411,53:PRINTINT(H)
260 PRINT "WAIT UNTIL THE PHYSICAL END":WAITS9408,16:H=H+(T1-T1)/60-10
270 PRINT "PRESS SPACE FOR REVERSE SEARCH TIMES":WAITS9410,4,4
276 :
278 REM TOTAL TAPE LENGTH = LOAD TIMES + BLANK TAPE AT END + MENU LOAD TIME
280 IFLEFT$(A$(1),4)="MENU"THENH=H+A(2)
290 PRINT "CORRECTED TAPE LENGTH"INT(H)
296 :
298 REM THE REVERSE SIDE SEARCH TIMES ARE NOW CALCULATED
300 FORI=1TOJ:H=H-A(I):M=H:IFM<200THENM=.78*M:GOTO320
310 GOSUB160:IFM>740THENM=M+3
320 PRINTA$(I):INT(M)
330 IFI/22=INT(I/22)THENPRINT "PRESS SPACE TO CONTINUE":WAITS9410,4,4
340 NEXT

```

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First position the tape to the correct point and then type in the following line to save your program.

TI = TI:SAVE "NAME" :?(TI - T)/60

The program will save in the normal fashion, but it will also tell you how long it took. Note this time, rewind the tape and load in your menu. The menu can be updated by adding your new program name, changing variables F and G and using the search time number that you had previously entered. Then calculate a new search time for the next addition, add the save time to the accumulated time, and change your note in the program. Use this time and the listing for the tape timer to calculate your new time.

Simply pick the line you need from the choices beginning at line 150. The remarks at the end of each line should make your choice easy, and the PET calculator mode will make the calculation easy. The value of M in the equation is the length of the tape minus the left number in the remark statement. For example, suppose your time to that point is 682 and you just saved an 87-second program. Adding those two numbers gives you 769 seconds. That

places us on line 180 of the listing so we must subtract 600 to get M (169). The new search value is $401 + .54 \times 169$ or 492 (49.2 seconds).

By the way, if the record and play buttons weren't already pressed when you typed in the save command, you'll have to be very careful to get the times to come out right. Type the line in but do not hit the return key. Then push the record and play keys at the same time that you push the return key.

Final Thoughts

When typing in the menu program be sure to remove all remarks. Your program will load about twice as fast that way. I hope that you get as much use out of this as I have. These programs have greatly enhanced my use of the PET Tape Operating System.

Dale De Priest is the manager of Circuit Development and Document Control at ISS Sperry Univac. He has an associate degree in Electrical Engineering Technology from Central Technical Institute in Kansas City. He can be contacted at: 611 Galen Drive, San Jose, CA 95123.

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(Continued from page 21)

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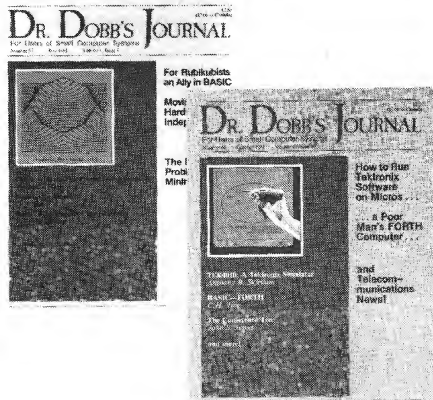
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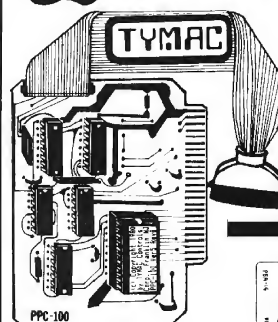
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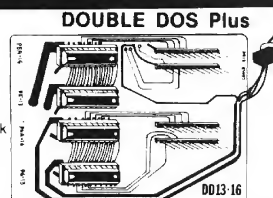
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Software Catalog

Name: **Color Editor**
System: TRS-80C
Memory: 32K
Language: Assembly
Language

Description: *Color Editor* is used for program development and text processing. It allows use of the upper and lower case features of the Color Computer and can print letters or programs on a printer attached to the RS-232 port. It has change and search commands that work on one or all lines and can copy or move sentences or paragraphs anywhere in the file. Lines can be inserted, deleted, or moved. Your work can be saved and later retrieved on cassette.

Price: \$29.95 includes cassette and instructions

Available:
Computerware
P.O. Box 668
Encinitas, CA 92024
(714) 436-3512

Name: **The Merger
VisiBlend**

System: Apple II or Apple II Plus

Memory: 48K
Language: Applesoft in ROM
Hardware: Disk II
Description: *The Merger* is a utility that aids users of *The Data Factory* and *The Invoice Factory*. Merge data from fields in either program into those of another file. *VisiBlend* allows users of *VisiCalc*TM to combine the data in multiple *VisiCalc*TM files, merging data across files. (*VisiCalc* is a trademark of Personal Software, Inc.)

Price: \$50 each

Available:
Micro Lab
2310 Skokie Valley Rd.
Highland Park, IL 60035

Name: **PET Library Card
Maker**

System: PET
Memory: 16K
Language: BASIC
Hardware: IDS 460 printer
Description: Prints a full set of library cards on tear-off card stock. The information is

typed once to the PET screen. You can preview the card, make corrections, then with one keystroke, print a set of up to 7 library cards. The program does all the formatting. A tape file can be made. For all small libraries.

Price: \$80 - Canadian
Includes cassette tape
Author: J. Horemans

Available:
M&W Computer Stores
Sheridan Corporate Centre
2155 Leanne Blvd., Unit 3
Mississauga, Ontario
Canada L5K 2K8

Name: **Inventory System**
System: OS65U
Memory: 48K
Language: BASIC
Hardware: OSI C-2 or C-3 series

Description: *Inventory System* is an integrated portion of EIS General Accounting Systems. It has perpetual inventory, sales invoicing, accounts receivable, bills of materials, and interrelated purchase orders; information on availability, cost ordering of low or out-of-stock inventory items.

Price: \$1,200.00
Includes three program disks and a step-by-step user's manual.

Available:
Electronic Information
Systems, Inc.
P.O. Box 5893
Athens, GA 30604
(404) 353-2858

Name: **Turf Management**
System: OSI C4P MF
Language: BASIC under OSI 65D

Hardware: Disk drive, optional printer
Description: A program that provides the characteristics of eight common grass species, giving optimum growing conditions, use, techniques for establishment, lime and fertilizer requirements, and pest management and control for general insect and weed problems. Rates of seed required for establishment and amounts of

chemicals needed for each required application can be calculated given the dimensions of the area. The program can be customized to suit the area of the country and availability of chemicals used for fertilizer and pest control.

Price: \$100.00
Includes 5¼" disk and documentation ppd.
Modification to operate with other systems can be requested.

Author: J. Benton Jones, Jr.

Available:
Benton Laboratories, Inc.
P.O. Box 5455
Athens, GA 30604

Name: **SCORE: The
Academic
Assistant**

System: Apple II Plus (or Apple II with Applesoft on firmware card)

Memory: 48K
Language: Applesoft and machine
Hardware: 80-column printer; optical mark reader (Chatsworth, HEI or Scan-tron) highly recommended

Description: *SCORE* is a comprehensive set of programs which will score multiple choice tests, conduct comprehensive item analyses, maintain academic records, prepare frequency distributions, and individualized student feedback, and much more. This package interfaces the Apple with the Chatsworth, HEI, or Scan-tron optical mark readers.

Price: \$395.00
Includes program disk, backup disk, data disk, comprehensive manual, ongoing support

Author: Bryan Hendricks, and Bob Bermant

Available:
Scientific Software Assoc., Ltd.
P.O. Box 208
Wausau, WI 54401
(715) 845-2066

Name: **Napoleon's
Campaigns: 1813
& 1815**

System: Apple II
Memory: 48K
Language: Applesoft in ROM
Hardware: Disk Drive
Description: Corps-level game simulating the last campaigns of Napoleon: Leipzig and Waterloo. Displayed on 18 x 21 hex grid maps in hi-res graphics. Computer acts as corps commander.

Price: \$59.95
Includes one diskette, rulebook, player aid card, two-sided map boards, 100 counters.

Available:
Strategic Simulations, Inc.
465 Fairchild Drive
Suite 108
Mountain View, CA 94043

Name: **TRS-80 Color
Computer
Learning Lab
(26-3153)**

System: TRS-80 Color Computer

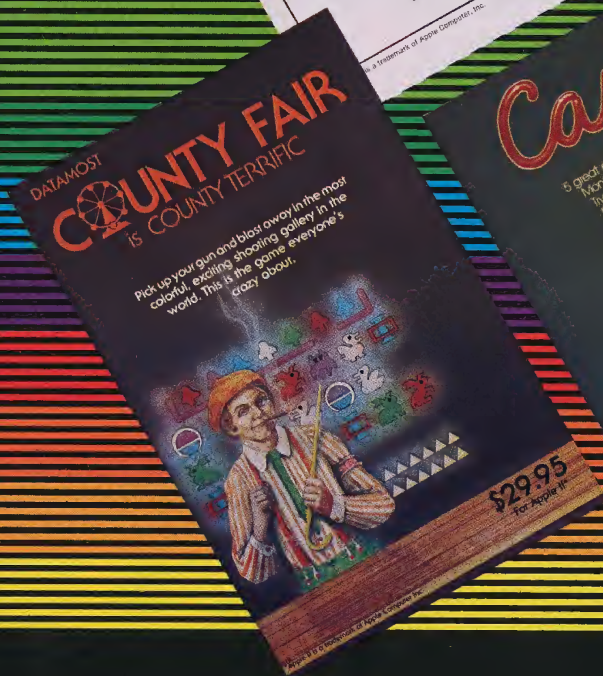
Memory: 4K, 16K, 32K
Language: Color BASIC
Hardware: Cassette
Description: A new self-instruction system that teaches user how to program in Color BASIC. Allows student to develop gradually through writing and editing longer, more complex programs. Example programs are practical and can be used for educational, family and personal purposes. The lab is divided into three sections: introduction to the computer; programming the computer; programming guides and tools to make programming easier, faster and more fun. The lessons take full advantage of color graphics and sound available from the TRS-80 Color Computer.

Price: \$49.95
Includes eight program cassettes and 30-lesson text

Author: Radio Shack
Available:
Radio Shack

(Continued on page 94)

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Chatsworth, CA 91311
(213) 709-1202

Software Catalog (Continued)

Name: **The Terrapin Logo Language**

System: Apple II or Apple II Plus

Memory: 64K, 48K Apple with 16K memory extension

Language: Terrapin Logo Language

Hardware: 1 disk drive

Description: The Logo language is the most powerful interpretive language ever devised for the Apple II. Yet, it is probably the easiest to use as well. It is designed so that young children can easily control the power of computers without having to know how to program. However, advanced programmers will enjoy the many features common to artificial intelligence research languages permitting programs of great power to be written quickly and easily. (Language is licensed by Mass. Institute of Technology.)

Price: \$149.95

Includes language disk, utilities disk and documentation including tutorial and technical manual

Author: Leigh Klotz, Pat Sobalvarro, Steve Hain

Available:

Terrapin, Inc.
678 Massachusetts Ave.
Cambridge, MA 02139
(617) 492-8816

Name: **Alkemstone™**

System: Apple II, Apple II Plus, Apple III

Memory: 48K

Language: Machine

Hardware: DOS 3.3

Description: *Alkemstone*, is a computer adventure which offers a \$7500 cash reward to the first person who can recover the missing Alkemstone. The quest for the Alkemstone will lead the player through underground paths of the lair of the original owner. There are unusual messages, fragments of words, sketches and other clues written on the walls. Some items are distributed randomly, so that one may be visible numerous times while some will only appear once in several trips. Each trip will result in a different combination of possible hints. If all bits of information are pieced

together correctly, then the location of the Alkemstone will be obvious.

Price: \$39.95

Includes 1 disk, 24-page booklet

Author: Level-10

Available:

Level-10, a division of
Dakin5 Corp.
7475 Dakin St.
Denver, CO 80221
or local Apple dealer

Name: **Chem Lab Simulations #3 and #4**

System: Apple II
Atari 800

Memory: 48K

Language: Applesoft or Atari BASIC

Hardware: 48K Apple II with disk drive or 40K Atari 800 with disk drive

Description: High Technology Software Products, Inc., is pleased to announce the third and fourth additions to its series of chemistry laboratory simulations. *Chem Lab Simulations #3* contains four calorimetry experiments through which Hess' Law is demonstrated. *Chem Lab Simulations #4* utilizes two capillary tube experiments to illustrate principles of thermodynamics. Designed for college-level introductory chemistry courses, these simulations are also well suited for advanced high school students.

Price: \$100 each

Includes program diskette, 3-ring binder with complete documentation.

Author: J.I. Gelder

Available:

High Technology Software Products, Inc.
2201 N.E. 63rd St.
P.O. Box 14665
Oklahoma City, OK 73113
or computer retailers

Name: **K-RAZY Shoot-Out**

System: Atari 400/800

Memory: 8K ROM

Language: 6502 machine

Description: Fast action game.

(Continued on page 96)

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Author: K-BYTE

Available:

K-Byte
1705 Austin
Troy, Michigan 48099
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show the mnemonic instruction before it is executed in the same form as the disassembler shows it. You can set high and low trace limits; this lets the program execute without displaying the instructions until the address is within these limits. The third feature is the ability to set a breakpoint. This will let you stop execution at any address in memory. This breakpoint, and tracing, can be done in ROM.

Price: \$12.95

Includes 5 1/4" disk, documentation.

Author: Dave Pompea

Available:

DMP Systems
319 Hampton Blvd.
Rochester, N.Y. 14612

Name: **Debug**
System: OSI C1P/MF,
C4/MF

Memory: No Additional

Language: Machine

Description: This machine-code program is used with OSI's Extended Monitor to provide single stepping of your computer to trace machine-code programs one instruction at a time. As you step through the program the display will

Name: **UTIL1**
System: AIM 65
Memory: 16K
Language: AIM Assembler
Hardware: Standard AIM
Description: **UTIL1** is a 2K extension of the AIM 65 monitor. It interfaces to AIM via the user I/O ports and the user

function key 3. It adds 18 commands to AIM. Eight of these are associated with a Buffer Manager that gives AIM a virtual I/O capability. Up to 8 I/O devices are emulated in RAM. This gives the AIM editor move and copy capability. These I/O devices can be used with any AIM firmware or software that uses the AIM Active Output Device (AOD) and the Active Input Device (AID). An additional 10 commands provide utilities such as memory display, search and move, and an offset loader for AIM object files.

Price: \$25 object on cassette

\$5 16-page manual

\$25 commented assembly listing

Includes object assembled to your specified address. Should reside at top of RAM. Specify Address.

Author: Joel Swank

Available:

Nehalem Bay Software
P.O. Box 2006
Beaverton, OR 97075

Name: **Creature of the Maze**

System: Ohio Scientific

Memory: 8K
Language: BASIC-in-ROM
Hardware: Challenger C1P or Superboard Series I or II

Description: Incredibly realistic 3-D graphics lock you into combat with the "Creature of the Maze." Each game starts with a new and different maze, created and displayed for you to ponder, but only for a short moment. Then the screen clears and you find yourself looking down long corridors, peeking around corners and searching for your enemy. The hallways explode with your laser blasts as the message across the screen spells out, "The monster is near." Tremendous fun with ten skill levels and hundreds of maze sizes to choose from.

Price: \$14.95

Includes cassette, user's manual with objectives, options, and suggestions for modification

Author: John H. DeRosa

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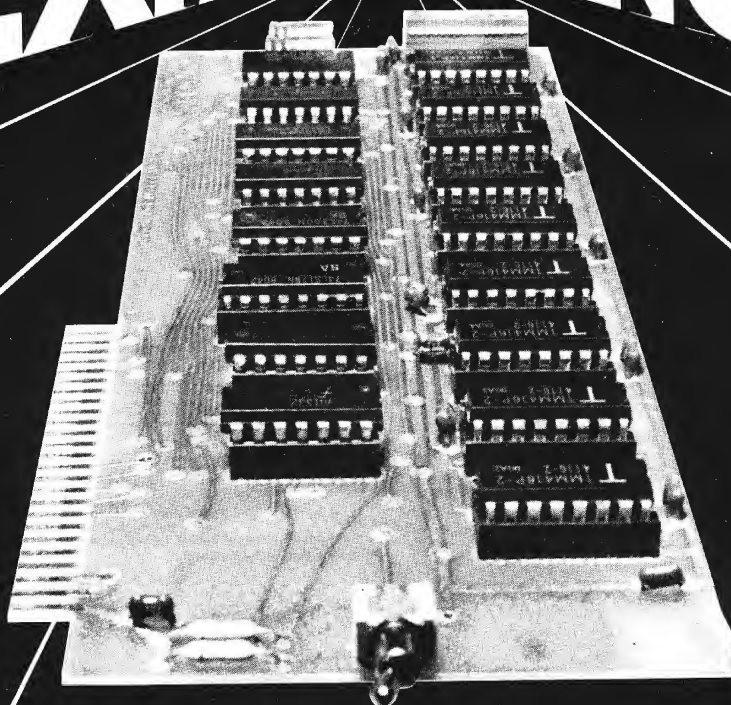
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6809 Bibliography

18. Commodore Interface (July, 1981)

Anon., "Super PET," pg. 18-20.
Questions and answers on the new Super PET based on a 6502 plus 6809.

19. MICRO No. 41 (October, 1981)

Puckett, Dale L., "The 6809 and the S-50 Bus," pg. 68-73.
The 6809 is much easier to work with than the 6800, and the programs are about 30 percent shorter and run about 30-40 percent faster.

Steiner, John, "The Radio Shack Color Computer: A 6809-based System," pg. 9-10.

The TRS-80 Color Computer is one of the most popular and versatile 6809-based systems to date. An outline of the features is given.

20. Apple Assembly Line 2, Issue 1 (October, 1981)

Wiggs, Chris and Sander-Cederlof, Robert, "6809 Cross Assembler," pg. 12.

Patches for the S-C Assembler Version 4.0 are available to give a brand new assembler for the 6809.

21. MICRO No. 42 (November, 1981)

Steiner, John, "Lunar Lander," pg. 41-44.

Animated graphics in BASIC for the 6809-based TRS-80 Color Computer.

Capouch, Brian, "OS-9 and the 6809: Revolutionary Tools," pg. 81-86.

The Microware OS-9 operating system is an advanced software package for the 6809. Also described is BASIC09, a high-level programming system (alternative to a BASIC interpreter or compiler). Illustrative listings of a pair of BASIC09 procedures in source code are given.

22. FWAUG Newsletter 2, No. 6 (October, 1981)

Hardenburg, Hal and McVay, Ray, "Concerning the 6502 and 6800," pg. 25-26.

Notes comparing the 6502, 6809 and the 68000 microprocessors, including a report that the Apple in the future may use the new 68000 microprocessor.

23. BYTE 6, No. 11 (November, 1981)

Walker, Gregory, "Toward a Structured 6809 Assembly Language, Part 1," pg. 370-382.

An introduction to structured assembly language for the 6809.

24. Stems From Apple 4, Issue 9 (September, 1981)

Hardenbergh, Hal W., "To Persons Interested in Both the 6502 and the 6800," pg. 5-14.

A comparison of the 6502, 6809 and the 68000 microprocessors, including an assembly language program for the 68000 multiply routine.

25. Compute! 3, No. 10, Issue 18 (November, 1981)

MacLean, Bill, "SuperPET: A Preview," pg. 38-40.

A rundown on the SuperPET micro which incorporates both the 6502 and the 6809.

26. BYTE 6, No. 12 (December, 1981)

Barden, William, "Color Computer from A to D," pg. 134-160.
A detailed look at the Radio Shack TRS-80 Color Computer, based on the 6809 microprocessor.

Walker, Gregory, "Toward a Structured 6809 Assembly Language," pg. 198-228.

Part 2 discusses implementing a structured assembler.

27. KB Microcomputing 5, No. 12, Issue No. 160 (December, 1981)

Stark, Peter A., "68XX Secrets," pg. 116-130.

A review of Dynamite, a good disassembler running on a 6809 FLEX 9 disk operating system. Notes on building a 6809 48K system.

28. Compute! 3, No. 12 (December, 1981)

Anon., "A Look at SuperPET," pg. 130-132.

Features of the CBM SuperPET and several useful utilities for this 6809-based system.

29. Compute! 4, No. 1, Issue 20 (January, 1982)

Mansfield, Richard, "BRANCH NEVER and QUIF Assembling on SuperPET," pg. 146-149.

Discussion of using some of the special 6809 statements available when assembling on the SuperPET.

30. MICRO No. 44 (January, 1982)

Tenny, Ralph, "Experimenters and the Color Computer," pg. 18-22.

A summary of the normal capabilities of the TRS-80 Color Computer and an examination of the unit's I/O capability. Also information on hardware for I/O use.

31. Apple Assembly Line 2, Issue 3 (December, 1981)

Sander-Cederlof, Bob, "EXCEL-9: A 6809 Card with FLEX," pg. 1.
A board with a 6809E CPU, 8K of ROM and an interval timer with built-in linkage routines for calling 6809 routines from Applesoft, Integer BASIC, or from 6502 machine language.

32. KB Microcomputing 6, No. 1, Issue 61 (January, 1982)

Wolf, Michael A., "Changing Chips in Midstream," pg. 96-100.
Discussion of the use of the 6809 microprocessor in the Radio Shack Color Computer.

33. KB Microcomputing 6, No. 2, Issue 62 (February, 1982)

Stark, Peter A., "6800 Secrets," pg. 84-98.

More bench tests on various microprocessor-equipped systems. Includes several related to the 6809 chip.

34. MICRO No. 45 (February, 1982)

Garrett, Leo E., "Utilities for the Color Computer," pg. 9-15.
A versatile routine allowing TRS-80 Color Computer users to dump or disassemble the 6809 or ASCII code in any section of memory, including the BASIC or expansion ROMs.

Staff, "MICRO Software Catalog," pg. 117-121.
Includes items of software for 6809 systems.

6502 Bibliography

1. MICRO No. 43 (December, 1981)

Traeger, John C., "Data Collection with Your Micro," pg. 9-11.

How to construct and implement an interface which enables high-speed sampling and recording of experimental data. Written for an AIM 65, it is readily adapted to any 6502 microprocessor with either a 6502 or 6222 interface adapter.

2. PEEK(65) 2, No. 12 (December, 1981)

Cook, William H., "Add an 8-Inch Floppy to the C2-4F/C4P," pg. 2-4.

A hardware article for OSI users. Modifications for the 502 CPU board and detailed information on the interconnections of the 470 Floppy Disk Controller board with the disk drive are given. Thirteen signal lines are run to the Siemens FDD 400-8 drive.

3. BYTE 6, No. 12 (December, 1981)

Jacobs, Jacob R., "Generating Programs Automatically," pg. 352-362.

Let your Apple II do the programming. Three programs are written in Applesoft BASIC. These utilities help set up your desired program with data entry, data output, instructions, etc. Sample dialogs in running the program are given in the article.

4. BYTE 6, No. 12 (December, 1981)

Kopp, Gregory L., "Discovering Atari's 'Hidden' Graphics," pg. 98-102.

Improper graphics commands on the Atari often leads to unexpected results. Some of these undocumented commands may be used to advantage. A chart of useful 'hidden' commands are given and example listings demonstrate the effect.

5. Apple-Dayton 2, No. 12 (December, 1981)

Brungart, David L., "Organizing Applesoft," pg. 19-25.

Listing and discussion of a program utility package used to set up temporary utility routines to ease the task of writing Applesoft programs in an orderly manner.

6. KB Microcomputing 5, No. 12, Issue No. 60 (December, 1981)

Young, John E., "Poor Man's Memory Expansion for the OSI," pg. 56-60.

An inexpensive way to expand the memory of the Superboard II or Challenger C1P. Instead of using a \$300 OSI 610 expansion board, a method to implement a \$30 16K static RAM board is described.

7. Call —A.P.P.L.E. 4, No. 9 (November/December, 1981)

Anon., "Puffin," pg. 13-42.

A DOS to Pascal File Converter for the Apple. A menu of four commands is presented: Catalog, Display, Transfer and Quit. Earlier a program called Huffin to convert Pascal files back to DOS was published (Call —A.P.P.L.E. Oct., 1982).

8. Softalk 2, No. 4 (December, 1981)

Coats, Douglas E. and Waldman, Cy H., "FORTRAN," pg. 160-172.

Comparisons of Apple FORTRAN and Microsoft FORTRAN for the Apple. Includes versions using "The Mill" and the Softcard accessories for the Apple.

9. Nibble 2, No. 8 (December, 1981)

Exner, Chris; Guy, Rudy; and Harvery, Mike, "Trend Reporting, Analysis, and Control," pg. 7-29.

A group of three extensions to the Apple-based TRAC system. Budget TRAC allows you to be aware of where your money goes, TRAC Spending Graph will graph the data in hi-res, and TRAC Plus shows how to get the best use of the system.

10. Creative Computing 7, No. 12 (December, 1981)

Brewster, Keith, "Who's Afraid of the Big Bad Matrix?," pg. 168-173.

Arrays and Matrix operations on the Atari are discussed and illustrated with numerous listings.

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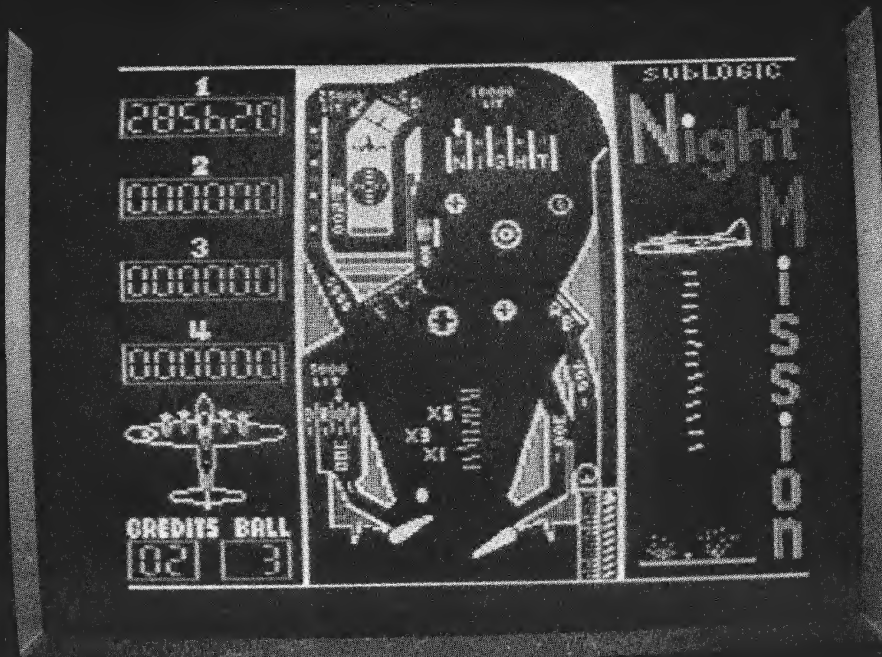
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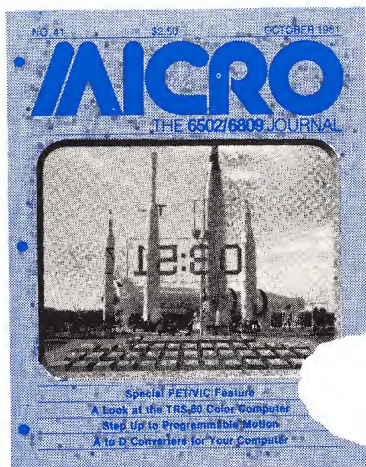
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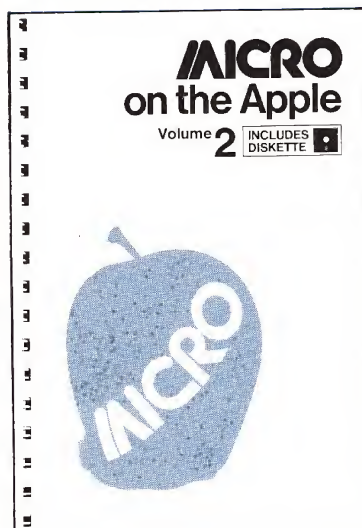
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| | | TOTAL | _____ | | |

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PET/CBM

PET — "Personal Electronic Transactor"

CBM — "Commodore Business Machine"

6502-based computer, manufactured by Commodore Business Machines

PET models include graphic keyboard

CBM models include business keyboard

Available in 4K, 8K, 16K, 32K, and 96K configurations

All models, except 8000 series, include 25-row by 40-column screen. 8016, 8032, and 8096 have 25 by 80 screen.

Two 256-character sets — one for graphics, one (with lower case) for business

Memory expansion bus, parallel interface, IEEE-488 instrumentation bus standard

Reliable cassette operating system, powerful screen editing and character-programmable cursor control are characteristic of PET/CBM.

VIC and SuperPET have many features in common with PET/CBM.

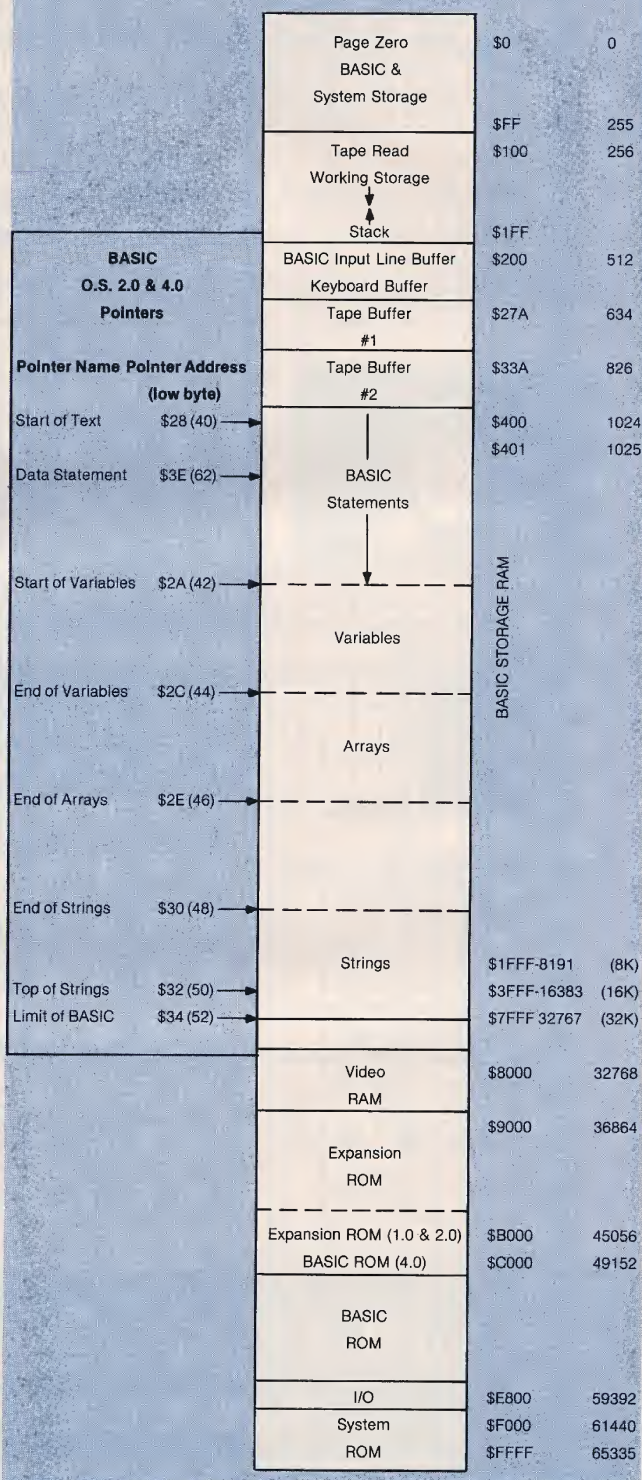
Parallel Port Connector

| Upper Pin Identification Character | Signal Label | Lower Pin Identification Character | Signal Label |
|------------------------------------|------------------|------------------------------------|--------------|
| 1 | Ground | A | GND |
| 2 | T.V. Video | B | CA1 |
| 3 | IEEE-SRQ | C | PA0 |
| 4 | IEEE-EOI | D | PA1 |
| 5 | Diagnostic Sense | E | PA2 |
| 6 | Tape #1 READ | F | PA3 |
| 7 | Tape #2 READ | H | PA4 |
| 8 | Tape Write | J | PA5 |
| 9 | T.V. Vertical | K | PA6 |
| 10 | T.V. Horizontal | L | PA7 |
| 11 | GND | M | CB2 |
| 12 | GND | N | GND |

IEEE-488 Connector

| PET Edge-card Pin Numbers | Standard IEEE Connector Pin Numbers | IEEE Signal Mnemonic |
|---------------------------|-------------------------------------|----------------------|
| Upper Pins | | |
| 1 | 1 | DI01 |
| 2 | 2 | DI02 |
| 3 | 3 | DI03 |
| 4 | 4 | DI04 |
| 5 | 5 | EOI |
| 6 | 6 | DAV |
| 7 | 7 | NRFD |
| 8 | 8 | NDAC |
| 9 | 9 | IFC |
| 10 | 10 | SRQ |
| 11 | 11 | ATN |
| 12 | 12 | GND |
| Lower Pins | | |
| A | 13 | DI05 |
| B | 14 | DI06 |
| C | 15 | DI07 |
| D | 16 | DI08 |
| E | 17 | REN |
| F | 18 | GND |
| H | 19 | GND |
| J | 20 | GND |
| K | 21 | GND |
| L | 22 | GND |
| M | 23 | GND |
| N | 24 | GND |

Memory Map



MICRO PET/CBM Data Sheet #4

PET/CBM

| Decimal | Hex | ASCII | Screen | BASIC | 6502 | Decimal | Hex | ASCII | Screen | BASIC | 6502 | Decimal | Hex | ASCII | Screen | BASIC | 6502 | Decimal | Hex | ASCII | Screen | BASIC | 6502 |
|---------|-----|-------|--------|--------|--------|---------|-----|-------|--------|-------|--------|---------|-----|-------|--------|-------|--------|---------|-----|-------|--------|-------|-------|
| 0 | 00 | @ | | BRK | ORA(X) | 64 | 40 | @ | | RTI | FOR(X) | 128 | 80 | | | END | STA(X) | 192 | C0 | | | TAN | CFY # |
| 1 | 01 | A | | ORA(X) | ASL X | 65 | 41 | A | | FOR | FOR(X) | 129 | 81 | | | FOR | STA(X) | 193 | C1 | | | PEEK | CFY # |
| 2 | 02 | B | | ORA(X) | ASL X | 66 | 42 | B | | FOR | FOR(X) | 130 | 82 | | | FOR | STA(X) | 194 | C2 | | | LEN | CFY # |
| 3 | 03 | C | | ORA(X) | ASL X | 67 | 43 | C | | FOR | FOR(X) | 131 | 83 | | | FOR | STA(X) | 195 | C3 | | | LEN | CFY # |
| 4 | 04 | D | | ORA(X) | ASL X | 68 | 44 | D | | FOR | FOR(X) | 132 | 84 | | | FOR | STA(X) | 196 | C4 | | | LEN | CFY # |
| 5 | 05 | E | | ORA(X) | ASL X | 69 | 45 | E | | FOR | FOR(X) | 133 | 85 | | | FOR | STA(X) | 197 | C5 | | | LEN | CFY # |
| 6 | 06 | F | | ORA(X) | ASL X | 70 | 46 | F | | FOR | FOR(X) | 134 | 86 | | | FOR | STA(X) | 198 | C6 | | | LEN | CFY # |
| 7 | 07 | G | | ORA(X) | ASL X | 71 | 47 | G | | FOR | FOR(X) | 135 | 87 | | | FOR | STA(X) | 199 | C7 | | | LEN | CFY # |
| 8 | 08 | H | | ORA(X) | ASL X | 72 | 48 | H | | FOR | FOR(X) | 136 | 88 | | | FOR | STA(X) | 200 | C8 | | | LEN | CFY # |
| 9 | 09 | I | | ORA(X) | ASL X | 73 | 49 | I | | FOR | FOR(X) | 137 | 89 | | | FOR | STA(X) | 201 | C9 | | | LEN | CFY # |
| 10 | 0A | J | | ORA(X) | ASL X | 74 | 4A | J | | FOR | FOR(X) | 138 | 8A | | | FOR | STA(X) | 202 | CA | | | LEN | CFY # |
| 11 | 0B | K | | ORA(X) | ASL X | 75 | 4B | K | | FOR | FOR(X) | 139 | 8B | | | FOR | STA(X) | 203 | CB | | | LEN | CFY # |
| 12 | 0C | L | | ORA(X) | ASL X | 76 | 4C | L | | FOR | FOR(X) | 140 | 8C | | | FOR | STA(X) | 204 | CC | | | LEN | CFY # |
| 13 | 0D | M | | ORA(X) | ASL X | 77 | 4D | M | | FOR | FOR(X) | 141 | 8D | | | FOR | STA(X) | 205 | CD | | | LEN | CFY # |
| 14 | 0E | N | | ORA(X) | ASL X | 78 | 4E | N | | FOR | FOR(X) | 142 | 8E | | | FOR | STA(X) | 206 | CE | | | LEN | CFY # |
| 15 | 0F | O | | ORA(X) | ASL X | 79 | 4F | O | | FOR | FOR(X) | 143 | 8F | | | FOR | STA(X) | 207 | CF | | | LEN | CFY # |
| 16 | 10 | P | | ORA(X) | ASL X | 80 | 50 | P | | FOR | FOR(X) | 144 | 90 | | | FOR | STA(X) | 208 | D0 | | | LEN | CFY # |
| 17 | 11 | Q | | ORA(X) | ASL X | 81 | 51 | Q | | FOR | FOR(X) | 145 | 91 | | | FOR | STA(X) | 209 | D1 | | | LEN | CFY # |
| 18 | 12 | R | | ORA(X) | ASL X | 82 | 52 | R | | FOR | FOR(X) | 146 | 92 | | | FOR | STA(X) | 210 | D2 | | | LEN | CFY # |
| 19 | 13 | S | | ORA(X) | ASL X | 83 | 53 | S | | FOR | FOR(X) | 147 | 93 | | | FOR | STA(X) | 211 | D3 | | | LEN | CFY # |
| 20 | 14 | T | | ORA(X) | ASL X | 84 | 54 | T | | FOR | FOR(X) | 148 | 94 | | | FOR | STA(X) | 212 | D4 | | | LEN | CFY # |
| 21 | 15 | U | | ORA(X) | ASL X | 85 | 55 | U | | FOR | FOR(X) | 149 | 95 | | | FOR | STA(X) | 213 | D5 | | | LEN | CFY # |
| 22 | 16 | V | | ORA(X) | ASL X | 86 | 56 | V | | FOR | FOR(X) | 150 | 96 | | | FOR | STA(X) | 214 | D6 | | | LEN | CFY # |
| 23 | 17 | W | | ORA(X) | ASL X | 87 | 57 | W | | FOR | FOR(X) | 151 | 97 | | | FOR | STA(X) | 215 | D7 | | | LEN | CFY # |
| 24 | 18 | X | | ORA(X) | ASL X | 88 | 58 | X | | FOR | FOR(X) | 152 | 98 | | | FOR | STA(X) | 216 | D8 | | | LEN | CFY # |
| 25 | 19 | Y | | ORA(X) | ASL X | 89 | 59 | Y | | FOR | FOR(X) | 153 | 99 | | | FOR | STA(X) | 217 | D9 | | | LEN | CFY # |
| 26 | 1A | Z | | ORA(X) | ASL X | 90 | 5A | Z | | FOR | FOR(X) | 154 | 9A | | | FOR | STA(X) | 218 | DA | | | LEN | CFY # |
| 27 | 1B | [| | ORA(X) | ASL X | 91 | 5B | [| | FOR | FOR(X) | 155 | 9B | | | FOR | STA(X) | 219 | DB | | | LEN | CFY # |
| 28 | 1C | \ | | ORA(X) | ASL X | 92 | 5C | \ | | FOR | FOR(X) | 156 | 9C | | | FOR | STA(X) | 220 | DC | | | LEN | CFY # |
| 29 | 1D |] | | ORA(X) | ASL X | 93 | 5D |] | | FOR | FOR(X) | 157 | 9D | | | FOR | STA(X) | 221 | DD | | | LEN | CFY # |
| 30 | 1E | ^ | | ORA(X) | ASL X | 94 | 5E | ^ | | FOR | FOR(X) | 158 | 9E | | | FOR | STA(X) | 222 | DE | | | LEN | CFY # |
| 31 | 1F | _ | | ORA(X) | ASL X | 95 | 5F | _ | | FOR | FOR(X) | 159 | 9F | | | FOR | STA(X) | 223 | DF | | | LEN | CFY # |
| 32 | 20 | space | | ORA(X) | ASL X | 96 | 60 | space | | FOR | FOR(X) | 160 | A0 | | | FOR | STA(X) | 224 | E0 | | | LEN | CFY # |
| 33 | 21 | space | | ORA(X) | ASL X | 97 | 61 | space | | FOR | FOR(X) | 161 | A1 | | | FOR | STA(X) | 225 | E1 | | | LEN | CFY # |
| 34 | 22 | space | | ORA(X) | ASL X | 98 | 62 | space | | FOR | FOR(X) | 162 | A2 | | | FOR | STA(X) | 226 | E2 | | | LEN | CFY # |
| 35 | 23 | space | | ORA(X) | ASL X | 99 | 63 | space | | FOR | FOR(X) | 163 | A3 | | | FOR | STA(X) | 227 | E3 | | | LEN | CFY # |
| 36 | 24 | space | | ORA(X) | ASL X | 100 | 64 | space | | FOR | FOR(X) | 164 | A4 | | | FOR | STA(X) | 228 | E4 | | | LEN | CFY # |
| 37 | 25 | space | | ORA(X) | ASL X | 101 | 65 | space | | FOR | FOR(X) | 165 | A5 | | | FOR | STA(X) | 229 | E5 | | | LEN | CFY # |
| 38 | 26 | space | | ORA(X) | ASL X | 102 | 66 | space | | FOR | FOR(X) | 166 | A6 | | | FOR | STA(X) | 230 | E6 | | | LEN | CFY # |
| 39 | 27 | space | | ORA(X) | ASL X | 103 | 67 | space | | FOR | FOR(X) | 167 | A7 | | | FOR | STA(X) | 231 | E7 | | | LEN | CFY # |
| 40 | 28 | space | | ORA(X) | ASL X | 104 | 68 | space | | FOR | FOR(X) | 168 | A8 | | | FOR | STA(X) | 232 | E8 | | | LEN | CFY # |
| 41 | 29 | space | | ORA(X) | ASL X | 105 | 69 | space | | FOR | FOR(X) | 169 | A9 | | | FOR | STA(X) | 233 | E9 | | | LEN | CFY # |
| 42 | 2A | space | | ORA(X) | ASL X | 106 | 6A | space | | FOR | FOR(X) | 170 | AA | | | FOR | STA(X) | 234 | EA | | | LEN | CFY # |
| 43 | 2B | space | | ORA(X) | ASL X | 107 | 6B | space | | FOR | FOR(X) | 171 | AB | | | FOR | STA(X) | 235 | EB | | | LEN | CFY # |
| 44 | 2C | space | | ORA(X) | ASL X | 108 | 6C | space | | FOR | FOR(X) | 172 | AC | | | FOR | STA(X) | 236 | EC | | | LEN | CFY # |
| 45 | 2D | space | | ORA(X) | ASL X | 109 | 6D | space | | FOR | FOR(X) | 173 | AD | | | FOR | STA(X) | 237 | ED | | | LEN | CFY # |
| 46 | 2E | space | | ORA(X) | ASL X | 110 | 6E | space | | FOR | FOR(X) | 174 | AE | | | FOR | STA(X) | 238 | EE | | | LEN | CFY # |
| 47 | 2F | space | | ORA(X) | ASL X | 111 | 6F | space | | FOR | FOR(X) | 175 | AF | | | FOR | STA(X) | 239 | EF | | | LEN | CFY # |
| 48 | 30 | space | | ORA(X) | ASL X | 112 | 70 | space | | FOR | FOR(X) | 176 | B0 | | | FOR | STA(X) | 240 | F0 | | | LEN | CFY # |
| 49 | 31 | space | | ORA(X) | ASL X | 113 | 71 | space | | FOR | FOR(X) | 177 | B1 | | | FOR | STA(X) | 241 | F1 | | | LEN | CFY # |
| 50 | 32 | space | | ORA(X) | ASL X | 114 | 72 | space | | FOR | FOR(X) | 178 | B2 | | | FOR | STA(X) | 242 | F2 | | | LEN | CFY # |
| 51 | 33 | space | | ORA(X) | ASL X | 115 | 73 | space | | FOR | FOR(X) | 179 | B3 | | | FOR | STA(X) | 243 | F3 | | | LEN | CFY # |
| 52 | 34 | space | | ORA(X) | ASL X | 116 | 74 | space | | FOR | FOR(X) | 180 | B4 | | | FOR | STA(X) | 244 | F4 | | | LEN | CFY # |
| 53 | 35 | space | | ORA(X) | ASL X | 117 | 75 | space | | FOR | FOR(X) | 181 | B5 | | | FOR | STA(X) | 245 | F5 | | | LEN | CFY # |
| 54 | 36 | space | | ORA(X) | ASL X | 118 | 76 | space | | FOR | FOR(X) | 182 | B6 | | | FOR | STA(X) | 246 | F6 | | | LEN | CFY # |
| 55 | 37 | space | | ORA(X) | ASL X | 119 | 77 | space | | FOR | FOR(X) | 183 | B7 | | | FOR | STA(X) | 247 | F7 | | | LEN | CFY # |
| 56 | 38 | space | | ORA(X) | ASL X | 120 | 78 | space | | FOR | FOR(X) | 184 | B8 | | | FOR | STA(X) | 248 | F8 | | | LEN | CFY # |
| 57 | 39 | space | | ORA(X) | ASL X | 121 | 79 | space | | FOR | FOR(X) | 185 | B9 | | | FOR | STA(X) | 249 | F9 | | | LEN | CFY # |
| 58 | 3A | space | | ORA(X) | ASL X | 122 | 7A | space | | FOR | FOR(X) | 186 | BA | | | FOR | STA(X) | 250 | FA | | | LEN | CFY # |
| 59 | 3B | space | | ORA(X) | ASL X | 123 | 7B | space | | FOR | FOR(X) | 187 | BB | | | FOR | STA(X) | 251 | FB | | | LEN | CFY # |
| 60 | 3C | space | | ORA(X) | ASL X | 124 | 7C | space | | FOR | FOR(X) | 188 | BC | | | FOR | STA(X) | 252 | FC | | | LEN | CFY # |
| 61 | 3D | space | | ORA(X) | ASL X | 125 | 7D | space | | FOR | FOR(X) | 189 | BD | | | FOR | STA(X) | 253 | FD | | | LEN | CFY # |
| 62 | 3E | space | | ORA(X) | ASL X | 126 | 7E | space | | FOR | FOR(X) | 190 | BE | | | FOR | STA(X) | 254 | FE | | | LEN | CFY # |
| 63 | 3F | space | | ORA(X) | ASL X | 127 | 7F | space | | FOR | FOR(X) | 191 | BF | | | FOR | STA(X) | 255 | FF | | | LEN | CFY # |

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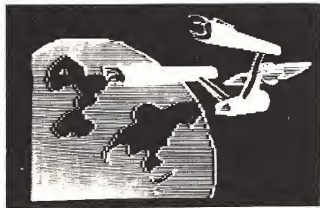
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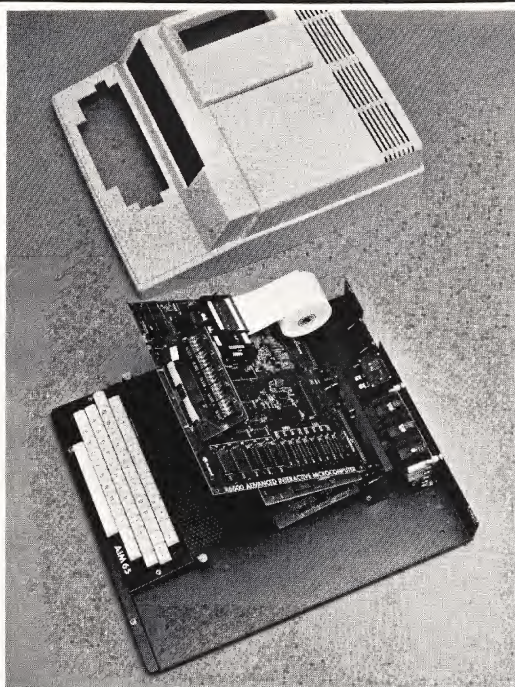
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